130C

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

130C
OSCILLOSCOPE

130C

CERTIFICATION

THE HEWLETT-PACKARD COMPANY CERTIFIES THAT THIS INSTRUMENT WAS THOROUGHLY TESTED AND INSPECTED AND FOUND TO MEET ITS PUBLISHED SPECIFICATIONS WHEN IT WAS SHIPPED FROM THE FACTORY.

HP FURTHER CERTIFIES THAT ITS CALIBRATION MEASUREMENTS ARE TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS TO THE EXTENT ALLOWED BY THE BUREAU'S CALIBRATION FACILITY.

OPERATING AND SERVICE MANUAL

MODEL 130C

SERIALS PREFIXED: 235

OSCILLOSCOPE

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Table 1-1. Specifications

SWEEP GENERATOR

INTERNAL SWEEP: 21 ranges, 1 μsec/cm to 5 sec/cm, accuracy within ±3%. Vernier provides continuous adjustment between ranges and extends slowest sweep to at least 12.5 sec/cm.

MAGNIFICATION: X2, X5, X10, X20, X50 overall sweep accuracy within ±5% for sweep rates which do not exceed a maximum rate of 0.2 μsec/cm.

AUTOMATIC TRIGGERING: Base line is displayed in the absence of an input signal.
Internal: 50 cps to 500 kc signal causing 0.5 cm or more vertical deflection and also from line voltage.
External: 50 cps to 500 kc, 0.5 volts peak-to-peak or more.
Trigger Slope: Positive or negative slope of external sync signals or internal vertical deflection signals.

AMPLITUDE SELECTION TRIGGERING:
Internal: 10 cps to 500 kc, 0.5 cm or more vertical deflection signal.
External: DC (dc to 500 kc) or AC (20 cps to 500 kc) coupled, 0.5 volts peak-to-peak or more.
Trigger Point and Slope: Internally from any point of the vertical waveform presented on screen or continuously variable from +10 volts to -10 volts on either positive or negative slope of external signal.

SINGLE SWEEP: Front panel switch permits single sweep operation.

VERTICAL AND HORIZONTAL AMPLIFIERS

BANDWIDTH:
DC Coupled: DC to 500 kc
AC Coupled (input): 10 cps to 500 kc.
AC Coupled (amplifier): 25 cps to 500 kc at 0.2 mv/cm sensitivity. Lower cut-off frequency (f_{CO}) is reduced as sensitivity is reduced; at 20 mv/cm f_{CO} is 0.25 cps. On less sensitive ranges, response extends to DC.

SENSITIVITY: 0.2 mv/cm to 20 v/cm. 16 ranges in 1,2,5,10 sequence with an attenuator accuracy within ±3%. Vernier permits continuous adjustment of sensitivity between ranges and extends minimum sensitivity to at least 50 v/cm.

INTERNAL CALIBRATOR: Approximately 350 cps square wave. 5 mv ±3%. Automatically connected for checking gain when the sensitivity is switched to CAL.

INPUT IMPEDANCE: 1 megohm shunted by 45 pf, constant on all sensitivity ranges.

MAXIMUM INPUT: 600 v peak (dc + ac).

BALANCED INPUT: On all sensitivity ranges.

COMMON MODE REJECTION: (dc to 50 kc) At least 40 db from 0.2 mv/cm through 0.2 volts/cm sensitivity; common mode signal not to exceed 4 volts p-p. At least 30 db from 0.5 volts/cm to 20 volts/cm; common mode signal not to exceed 40 volts p-p from .5 volts/cm through 2 volts/cm or 400 volts p-p from 5 volts/cm through 20 volts/cm.

PHASE SHIFT: With ±1° relative phase shift at frequencies up to 100 kc with verniers in CAL position and equal input sensitivities.

GENERAL

CALIBRATOR: Approximately 350 cps, 500 mv ±2% available at front panel.

CATHODE RAY TUBE: Ⓗ Type 5083-0353 (P31) Internal Graticule, mono-accelerator, 3000 volts accelerating potential. P2, P7, and P11 phosphors are available. Equipped with non-glaring safety glass faceplate. Yellow filter supplied with P7.

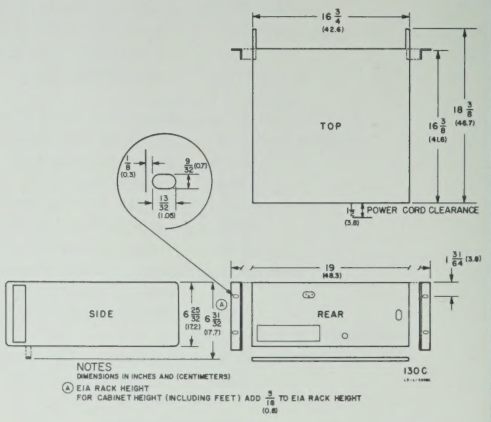
INTERNAL GRATICULE: Parallax-free 10 cm x 10 cm marked in cm squares. 2 mm subdivisions on major horizontal and vertical axis.

BEAM FINDER: Depressing Beam Finder control brings trace on CRT screen regardless of setting of balance, position or intensity controls.

INTENSITY MODULATION: Terminals on rear; +20 volt pulse blanks CRT at normal intensity.

POWER: 115 or 230 volts ±10%, 50 to 1000 cps. Approximately 90 watts.

DIMENSIONS:



WEIGHT: Net, 32 lbs. Shipping, 45 lbs.

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Company Model 130C Oscilloscope (shown in Figure 1-1) is a versatile instrument for laboratory, production line, or industrial process measurements. Horizontal and vertical display sensitivity is 200 microvolts per centimeter and the measurement bandwidth is 500 kc. A sweep magnifier of up to X50 allows expansion of a trace to the equivalent of 500 centimeters for viewing waveform details. Single sweep operation is also provided to allow observation of single shot phenomena or random occurrence events. Trigger adjustments are minimized by using either a front panel trigger-level control with preset stability or automatic triggering which provides a base line even with no input signal. Also, for fast, expanded sweep times where the automatic trigger baseline would be too dim, a free run mode may be used to provide a bright base line display. An off-screen trace may be easily located by depressing a front panel Beam Finder Button which returns the trace to the screen regardless of intensity, balance, or position settings. Careful engineering design of the Model 130C has resulted in high stability of gain and minimal DC drift. The Model 130C has an internal graticule CRT, which eliminates parallax ambiguity and minimizes reflections and glare. The instrument is packaged in the hp modular cabinet, allowing quick, easy conversion to rack mounting and also provides easy accessibility to internal circuits for maintenance.

1-3. DIFFERENCES BETWEEN INSTRUMENTS.

1-4. The Hewlett-Packard Company uses a two-section, eight-digit serial number to identify instruments (e.g. 000-00000). The serial number is located on a plate attached to the instrument rear panel. The first three digits are a serial prefix number also appearing on the title page of this manual, and the last five digits identify a specific instrument. If the first three digits of the instrument serial number are not the same as those appearing on the title page, change sheets included with the manual will define differences between other instruments and the Model 130C described herein. If the change sheets are missing, your hp Field Engineer can supply the information.

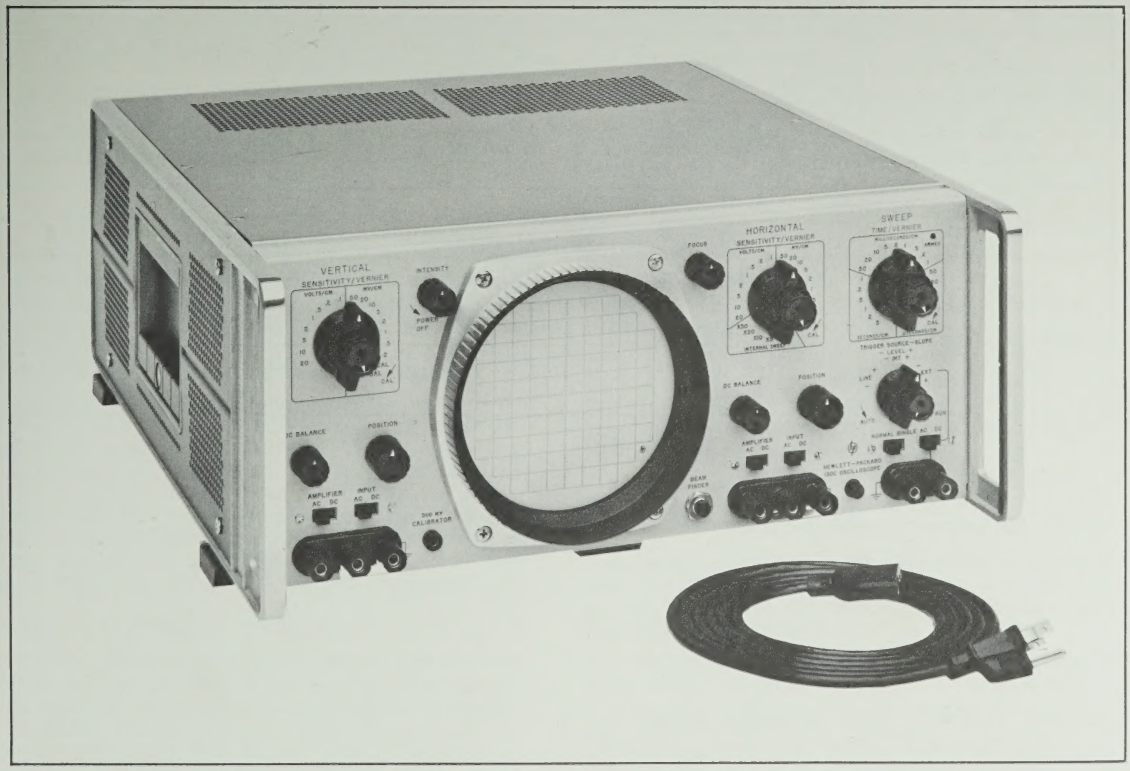


Figure 1-1. Model 130C Oscilloscope

1-5. CRT WARRANTY.

1-6. The cathode ray tube used in the Model 130C is covered by a warranty separate from the instrument warranty. The CRT warranty is included at the back of the manual for your use in the event of CRT failure during the warranty period.

1-7. EQUIPMENT SUPPLIED OR AVAILABLE.

1-8. Each instrument is supplied with detachable power cable and rack-mounting hardware. Other equipment available for use with the Model 130C is listed in Table 1-2.

1-9. OPTIONS COVERED.

1-10. This manual applies to Model 130C instruments with the options listed and described in Table 1-3. Replacement parts are listed in Section VI according to option numbers under Miscellaneous. If a part is not listed, order by description.

Table 1-2. Equipment and Accessories Available

1110A	Clip-on AC Current Probe
1111A	Current Amplifier (for 1110A)
10001A/C	Compensated 10:1 divider probe (5 ft cable)
10001B/D	Compensated 10:1 divider probe (10 ft cable)
10002A/C	Compensated 50:1 divider probe (5 ft cable)
10002B/D	Compensated 50:1 divider probe (10 ft cable)
10025A	General purpose straight-through probe
10100B	100 ohm termination for 1110A
10111A	Adapter, BNC female to dual banana plug

Table 1-3. Description of Options

Option Number	Description
02	Type P2 phosphor. This is a general-purpose phosphor, with relatively long persistence. It has a blue color under excitation which makes it usable for photography.
05	External graticule with scale light in lieu of internal graticule. Specify phosphor: P1, P2, P7, P11, P31 available.
06	Rear terminals in parallel with front panel terminals. Three-pin AN-type connectors (supplied) for horizontal and vertical signal inputs; BNC connector for trigger source.
07	Type P7 phosphor. This phosphor has a very long persistence, making it useful for low repetition rate and non-repetitive signals. (Amber filter supplied).
11	Type P11 phosphor. This phosphor has a short-persistence blue color which gives it the highest photographic sensitivity and the highest photographic writing rate of the three phosphor options.
13	6-31/32 in. x 19 in. x 3/16 in. front panel, suitable for attaching your own handles.

SECTION II
INSTALLATION

2-1. INCOMING INSPECTION.

2-2. MECHANICAL CHECK. When the Model 130C is received, verify that the package contents are complete and as ordered. Inspect the instrument for any physical damage such as a scratched panel surface broken knob, or connector, etc., incurred in shipping. Remove the instrument covers and visually check inside for loose or damaged components. To facilitate possible reshipment, keep the original packing if recommended for reuse (see Paragraph 2-12) until a satisfactory inspection of the instrument is completed. If damage is found, file a claim with the responsible carrier or insurance company and refer to the warranty page in this manual.

2-3. PERFORMANCE CHECK. The Model 130C may be checked for electrical operation within the specifications of Table 1-1 by following the procedures of Paragraph 5-3. These procedures allow a complete performance check with no internal connections or adjustments. If instrument does not operate as specified, refer to the warranty page of this manual.

2-4. RACK INSTALLATION.

2-5. The Model 130C is shipped from the factory ready for use as a bench instrument. The hardware necessary to rack-mount the instrument is packaged with the instrument: 1) Remove tilt stand and plastic feet, 2) Remove adhesive-backed trim strip from sides, 3) Attach filter strip along bottom of front panel, 4) Attach mounting flanges to sides with larger notch toward bottom of instrument.

2-6. COOLING.

2-7. Leave at least two inches clearance around the instrument for free circulation of air. In enclosed rack installations, be sure that the recirculation of warm air does not result in a high ambient temperature.

2-8. POWER REQUIREMENT.

2-9. The Model 130C operates on 115 or 230 volts ±10%, 50 to 1000 cps, single phase. The power required is approximately 90 watts. Before connecting the instrument to the power source, be sure that the 115-230 switch on the rear panel is in the proper position for the power source to be used. The line fuse is mounted behind the rear panel, and is accessible by removing the top cover. The 2 ampere fuse supplied is for either 115 or 230 volt operation.

2-10. INSTRUMENT GROUND.

2-11. To protect operating personnel, the National Electrical Manufacturer's Association recommends that the instrument panel and cabinet be grounded. The Model 130C is equipped with a three-conductor power cable which grounds the instrument when an appropriate outlet is used. The round pin on the power cable is the ground pin connection. To retain the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-12. REPACKAGING FOR SHIPMENT.

2-13. SUGGESTED PACKING MATERIALS. To package an instrument for shipment, some types of original packing materials may be reused, or your ℌ Field Engineer will help in getting suitable packaging. The types of original packing materials which may generally be reused are: (1) foam which encloses the instrument, (2) cardboard layers separated by foam supports, and (3) laminated cardboard cut to desired packing shape. Original packing materials which are a cardboard "accordion-like" filler are not recommended for shipment since the cushioning qualities are usually gone after one use. If packing materials recommended above are not available, first protect the instrument surfaces with heavy paper or sheets of cardboard flat against the instrument. Then place instrument in a durable carton, pad all sides with approximately 4 inches of new material designed specifically for package cushioning, mark carton clearly for proper handling, and insure adequately before shipping.

2-14. SHIPMENT FOR SERVICE OR REPAIR. If an instrument is being returned to Hewlett-Packard Company for servicing or repair, attach a tag to the instrument specifying owner, desired action, model number, and serial number. Ship the instrument to ℌ Customer Service at the address on the warranty page. All correspondence should refer to an instrument by Model number and the full (eight-digit) serial number.

2-15. INSTALLATION OF AMBER FILTER.

2-16. An amber filter (ℌ Stock No. 120A-83A) is supplied with the Model 130C, Option 07. This filter may be used to improve the long persistence characteristics desired for observing single-shot or very low frequency displays. To install the filter remove CRT bezel and proceed as follows:

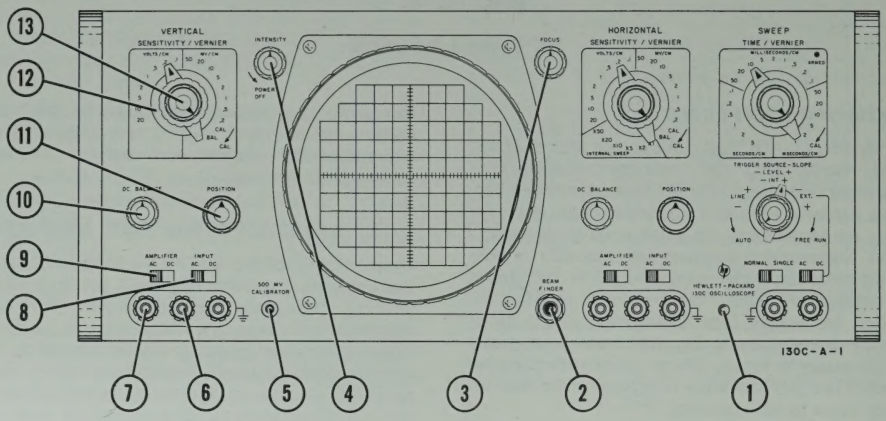
a. Set filter into bezel, aligning the large rectangular slots in the filter edge with guides in the bezel casting and sliding the filter down into the casting.

b. Loosen the clamp at the CRT socket. Carefully push the CRT toward the rear of the instrument to provide clearance for the thickness of the filter (approximately 1/8 inch).

c. Re-install the bezel and slide CRT forward until light mask on front of CRT just touches filter.

d. Tighten clamp to keep CRT from rotating. Note: Over-tightening clamp may damage CRT.

e. Check alignment of trace with graticule. If necessary adjust R329 Trace Align (rear panel).



1. Power on indicator. Glows when AC power is switched on.

2. BEAM FINDER. Returns off-screen trace to screen and intensifies trace (see Paragraph 3-14).

3. FOCUS. Adjusts trace sharpness.

4. INTENSITY. Adjusts trace brightness. When rotated fully counterclockwise, turns power off.

5. CALIBRATOR. Provides 500 mv p-p square wave for compensating probes or for use in external circuitry ($Z_{source} \approx 10$ KΩ).

6. Vertical -input terminal. Negative-going signals applied to this terminal cause upward deflection of the trace.

7. Vertical +input terminal. Positive-going signals applied to this terminal cause upward deflection of the trace.

8. INPUT AC-DC. Selects direct or capacitive coupling of the input signal (see Paragraph 3-31).

9. AMPLIFIER AC-DC. Selects internal direct or capacitive coupling on 7 highest sensitivity ranges (see Paragraph 3-31).

10. Vertical DC BALANCE. Adjusts internal DC levels to minimize trace shift when changing sensitivity ranges (or using VERNIER).

11. Vertical POSITION. Moves trace vertically.

12. Vertical SENSITIVITY. Sets the deflection sensitivity of the trace. Calibrated SENSITIVITY when VERNIER is fully cw (detented position).

13. VERNIER. Variable portion reduces deflection sensitivity for range selected. Allows continuous adjustment between ranges; extends minimum sensitivity to 50 V/CM. Calibrated SENSITIVITY when set to CAL.

Figure 3-1. Controls and Terminals (Vertical, CRT Display and Power)

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The Model 130C may be used in either of two basic modes of operation: (1) external signal to vertical input with internal horizontal sweep or (2) external signals into both horizontal and vertical inputs. The deflection sensitivity and bandwidth of the two amplifiers is indentical and the input to each amplifier may be easily changed to allow either single-ended inputs or balanced inputs. A choice of either AC or DC coupling, at the input and internally in the amplifier, is provided for both horizontal and vertical circuits. The internal horizontal sweep has 21 calibrated sweep times from 1μsec/cm to 5 sec/cm with a vernier for continuous coverage which can extend the slowest sweep speed to 12.5 sec/cm. Each sweep time may be magnified by choosing either X2, X5, X10, X20, or X50 range. The sweep can be triggered internally from the vertical deflection signal or the line frequency; external triggers can also be used, either AC or DC coupled to the sweep circuit. See Paragraph 3-16 for a brief operational check.

3-3. FRONT AND REAR PANEL FAMILIARIZATION.

3-4. FRONT PANEL. Figures 3-1 and 3-2 identify and briefly describe the Model 130C front panel controls, connectors, etc. To aid in proper operation, Paragraphs 3-6 through 3-15 provide a more extensive description of some front panel controls. Note that controls for vertical and horizontal inputs are identical in function and appearance except that the horizontal SENSITIVITY has six internal sweep positions.

3-5. REAR PANEL. The power cord connector, line fuse, and 115-230 volt switch are described in Paragraph 2-8. TRACE ALIGN is a screwdriver adjustment to align the CRT trace with the graticule. Relocating or reorienting the instrument within a magnetic field such as the earth's field may require adjustment of this control to maintain exact alignment. The Z AXIS INPUT allows trace intensity modulation by applying a modulating signal with the shorting link removed. At normal trace intensity (set on front panel), a +20 volt pulse will blank the trace. If not using the Z AXIS INPUT terminals, be sure the shorting link is in place.

3-6. SENSITIVITY.

3-7. SENSITIVITY control (vertical or horizontal) sets the deflection sensitivity of the display in millivolts per centimeter or volts per centimeter, when VERNIER is in CAL. position. In BAL position of the SENSITIVITY switch, the amplifier input is grounded and the input terminals are opened, to facilitate setting of the amplifier DC balance (see Paragraph 3-8 and Figure 3-3). In the CAL. position, an internal calibrator signal is applied to the amplifier input and the calibration accuracy can be checked by noting the deflection on the CRT as follows: (1) with no vertical input, when HORIZONTAL SENSITIVITY and VERNIER are set to CAL, a horizontal line 5 cm long should be displayed (if not the probable cause is misadjustment of the horizontal gain; see Section V), (2) with no horizontal input, when VERTICAL SENSITIVITY is set to CAL, a vertical line 5 cm long should be displayed (if not, the probable cause is misadjustment of the vertical gain; see Section V); if an internal sweep time is used a 5 cm p-p square wave should be displayed. The INTERNAL SWEEP positions of HORIZONTAL SENSITIVITY can be used to effectively expand a trace from two screen diameters in X2 to fifty screen diameters in X50.

3-8. DC BALANCE.

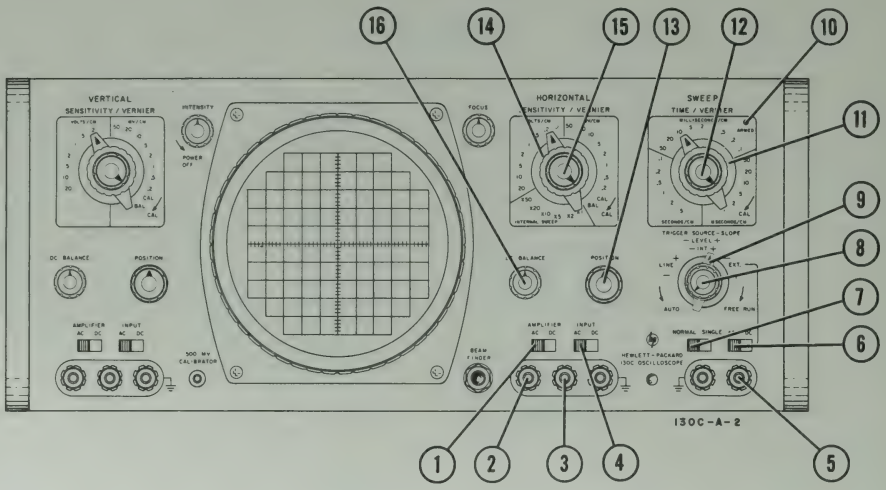
3-9. The DC BALANCE control has a range of about 40 screen diameters, i.e. it can effectively move the trace about 400 cm. Its purpose is to set internal amplifier operating conditions such that there is a minimum trace shift as SENSITIVITY is switched from range to range, or when VERNIER is used. This is especially important at the more sensitive ranges (toward 0.2 MV/CM) when the AMPLIFIER switch is set for DC coupling. Figure 3-3 provides the procedure for setting vertical and horizontal DC BALANCE properly. The setting may change during warmup or extended periods of operation and require periodic readjustment when the instrument is used DC coupled at high sensitivities.

Note

DC BALANCE is a "fine" control and should additional range be required to balance the amplifier a coarse DC balance adjustment is located within the instrument (see Section V for procedure).

3-10. LEVEL.

3-11. Through its variable range, LEVEL control determines the point on the triggering-source waveform at which the sweep starts. This trigger level is variable whether using external, internal, or line for the trigger source. By proper setting of LEVEL the sweep may be started at any point on a vertical deflection waveform (deflection $>$ 0.5 cm) when triggering internally or at a point between +10v to -10v on an external trigger signal. The + or - on the LEVEL control refers to the direction the triggering point moves on a waveform, regardless of the SLOPE setting (for example, turning LEVEL ccw moves triggering level toward a more negative point on the triggering waveform). When LEVEL is set fully counterclockwise to AUTO (detented position), the sweep will free run at a low repetition rate providing a baseline in the absence of a triggering signal and then provide automatic triggering of the sweep when a signal within specifications is applied. In AUTO an external trigger is always AC coupled. When LEVEL is set fully clockwise to FREE RUN (detented position),



1. AMPLIFIER AC-DC. Selects internal direct or capacitive coupling on 7 highest sensitivity ranges (see Paragraph 3-31).

2. Horizontal +input terminal. Positive-going signals applied to this terminal cause the trace to deflect to the right.

3. Horizontal -input terminal. Negative-going signals applied to this terminal cause the trace to deflect to the right.

4. INPUT AC-DC. Selects direct or capacitive coupling of the input signal (see Paragraph 3-31).

5. Trigger Input Terminal. Accepts external trigger signal.

6. Trigger Input AC-DC. Selects direct or capacitive coupling of external trigger signal (always AC coupled when LEVEL set to AUTO).

7. NORMAL-SINGLE. Selects normal sweep or single sweep operation (see Paragraph 3-12).

8. LEVEL. Selects free-running, automatic triggering, or variable amplitude triggering (see Paragraph 3-10).

9. TRIGGER SOURCE-SLOPE. Selects source of sweep trigger signal and slope on which trigger occurs. INT. triggers with internal vertical signal; LINE triggers on power line waveform; EXT. triggers on signal at trigger input terminal.

10. ARMED. Indicator glows when sweep is ready for trigger in SINGLE sweep operation.

11. SWEEP TIME. Selects time unit per centimeter of sweep. Calibrated sweep time when VERNIER is fully cw (detented position).

12. VERNIER. Variable portion reduces sweep time per centimeter for selected range. Allows continuous adjustment between ranges; extends slowest sweep speed to 12.5 sec/cm. Calibrated sweep when set to CAL.

13. Horizontal POSITION. Moves trace horizontally.

14. Horizontal SENSITIVITY. Sets the deflection sensitivity of the trace and selects internal sweep. Calibrated SENSITIVITY when VERNIER is fully cw (detented position).

15. VERNIER. Variable portion reduces deflection sensitivity for range selected. Allows continuous adjustment between ranges; extends minimum sensitivity to 50 V/CM. Calibrated SENSITIVITY when set to CAL.

16. Horizontal DC BALANCE. Adjusts internal DC levels to minimize trace shift when changing sensitivity ranges (or using VERNIER).

Figure 3-2. Controls and Terminals (Horizontal, Sweep, and Triggering)

the horizontal sweep is free running at a rate determined by the sweep time setting, and cannot be controlled by a triggering signal.

3-12. NORMAL-SINGLE.

3-13. When NORMAL-SINGLE is set to NORMAL, the horizontal sweep operates recurrently as determined by the triggering signal. In SINGLE position, the sweep can be triggered only once, after which it is locked out until armed by switching to NORMAL and back to SINGLE. The ARMED light is on in SINGLE position when the sweep is armed and ready to be triggered. To use the single sweep operation, LEVEL must be set anywhere in its variable range, i.e. not in AUTO or FREE RUN. See also Paragraph 3-24.

3-14. BEAM FINDER.

3-15. This paragraph will explain operation and function of the BEAM FINDER and also discuss some causes of no CRT display. The BEAM FINDER pushbutton is useful for locating a display which is not visible on the CRT for these common reasons: 1) DC unbalance in amplifier at high sensitivities, (and AMPLIFIER DC coupling), 2) amplifier being overloaded at input, or 3) intensity set too low. Depressing the BEAM FINDER defocuses and intensifies the CRT trace (or spot), and reduces the sensitivity of both horizontal and vertical amplifiers so the trace appears on-screen regardless of INTENSITY, DC BALANCE, and POSITION settings. The beam finder reduces amplifier gain enough to overcome the effective positioning range of the DC BALANCE controls, which amounts to as much as 40 screen diameters (i.e. 400 cm) at the highest amplifier sensitivity, as compared to only 2 screen diameters (20 cm) range for POSITION control. Because of the desensitization required to overcome DC BALANCE range, the POSITION controls are essentially inoperative when the BEAM FINDER is depressed. Therefore, always set POSITION to approximately "12 o'clock" before using the beam finder. To get maximum usefulness from the BEAM FINDER, the selected amplifier sensitivity and coupling should also be considered. At higher amplifier sensitivities (i.e. toward 0.2 MV/CM), if AMPLIFIER is set to AC, a DC unbalance in the amplifier cannot cause an off-screen deflection. Instead, the most probable cause is amplifier overload by the input signal or intensity may be set too low. At higher sensitivities with amplifier DC coupling, and trace not on screen, switch AMPLIFIER to AC and if trace now appears on-screen then a DC unbalance exists (to make DC BALANCE setting see Figure 3-3). At lower amplifier sensitivities, DC unbalance is eliminated as a cause for off-screen trace. Another cause of no display is non-triggering sweep and this can be checked by noting if trace appears when the automatic triggering mode is used (see Table 1-1 for specifications).

3-16. OPERATIONAL CHECK.

3-17. This procedure may be followed to check operation of most controls and circuits of the Model 130C.

a. Turn INTENSITY to about 12 o'clock position (turns AC power on). Allow several minutes warmup.

b. Set all VERNIERs to CAL.

c. Set horizontal and vertical AMPLIFIER and INPUT to AC.

d. Set vertical SENSITIVITY to CAL.

e. Set the horizontal SENSITIVITY to INTERNAL SWEEP X1 and set SWEEP TIME to 1 MILLISECONDS/CM.

f. Set TRIGGER SOURCE-SLOPE to INT. +, LEVEL to AUTO, and NORMAL-SINGLE to NORMAL.

g. Adjust both POSITION controls to center display. Adjust FOCUS for sharp, clear trace.

h. The height of the square wave displayed should be 5 cm.

3-18. OPERATING PROCEDURES.

3-19. Paragraphs 3-20 through 3-29, and the figures referenced, describe procedures for various operating modes and applications of the Model 130C. Before operating the Oscilloscope and following these procedures, it is recommended that Paragraphs 3-3 through 3-15 be read to become completely familiar with front panel controls. Also, Paragraphs 3-31 and 3-33 describe considerations which are important in most measurements with the Model 130C.

3-20. INTERNALLY TRIGGERED SWEEP OPERATION.

3-21. In this type operation, the sweep is triggered internally from the vertical signal or line frequency and the signal to be observed is applied to the vertical input; Figure 3-4 provides a step by step procedure. With TRIGGER SOURCE-SLOPE set to INT. + or -, the sweep is triggered when the vertical signal input causes a vertical deflection of 0.5 cm or more. With TRIGGER SOURCE-SLOPE set to LINE + or -, the sweep is triggered from the AC power line waveform. Function of LEVEL control is described in Paragraph 3-10.

3-22. EXTERNALLY TRIGGERED SWEEP OPERATION.

3-23. In this type operation the sweep is triggered from an externally applied signal and the signal to be observed is applied to the vertical input; Figure 3-5 provides the step by step procedure. With TRIGGER SOURCE-SLOPE set to EXT. + or -, the horizontal sweep is triggered by a signal of 0.5V p-p or more, applied to the trigger input terminals. Figure 3-5 explains use and specifications for AC or DC trigger input coupling; if LEVEL is set to AUTO, the external trigger signal is always AC coupled. Function of LEVEL control is explained in Paragraph 3-10.

3-24. SINGLE SWEEP OPERATION.

3-25. A step by step procedure for obtaining single sweep operation is contained in Figure 3-6. This method is useful for observing single shot phenomena or random events. With single sweep operation, the sweep occurs just once and cannot be retriggered until manually rearmed. See also Paragraph 3-12 for explanation of the SINGLE-NORMAL switch.

3-26. DIFFERENTIAL INPUT OPERATION.

3-27. Balanced inputs are provided on all SENSITIVITY ranges of both horizontal and vertical deflection amplifiers which allows measurement of the difference between two signals. This is called differential input operation and in this mode the two signals are subtracted algebraically and the difference is displayed as a single trace. This type of operation eliminates signals which are common to both inputs (referred to as the common mode signal) and displays signals peculiar to only one input. Figure 3-7 provides a step by step procedure for differential operation of the Model 130C. Common mode rejection expressed in decibels represents the ability of the amplifier to attenuate the common mode signal and this is summarized in Table 3-1 along with the maximum allowable peak-to-peak common mode signal to maintain these rejection ratios.

Table 3-1. Common Mode Rejection

SENSITIVITY	Maximum Peak-to-Peak Input	Minimum Common Mode Rejection (DC to 50 kc)
0.2 MV/CM thru 0.2 VOLTS/CM	4 volts	40 db
0.5 VOLTS/CM thru 2 VOLTS/CM	40 volts	30 db
5 VOLTS/CM thru 20 VOLTS/CM	400 volts	30 db

3-28. X-Y OPERATION.

3-29. In the X-Y mode of operation the internal sweep is disabled and external signals are applied to both the horizontal and vertical amplifiers. Figure 3-8 provides an operating procedure for obtaining Lissajous patterns or X-Y plots. The X-Y display is a graph of the vertical signal vs. the horizontal signal and is useful for displaying plots of voltage vs. current, hysteresis loops, pressure vs. strain (using strain gages), etc. Another important application for X-Y operation is to make phase shift measurements. The vertical and horizontal amplifiers have identical characteristics and less than ±1° relative phase shift from DC to 100 kc when VERNIERs are set to CAL. and amplifier SENSITIVITY settings are equal. hp Application Note 29 describes a convenient method for measuring phase shift. When measuring phase shift at very low frequencies, use both AMPLIFIER DC and INPUT DC to eliminate phase differences contributed by the AC coupling capacitors.

3-30. OPERATING CONSIDERATIONS.

3-31. USE OF AMPLIFIER AND INPUT AC-DC.

3-32. Different combinations of AMPLIFIER and INPUT coupling will provide various advantages in the characteristics of operation depending on the waveform to be displayed. Table 3-2 summarizes the typical low-frequency 3 db cutoff point with different SENSITIVITY and coupling settings; typical applications are also given. The high frequency 3 db cutoff point is 500 kc in all cases. For SENSITIVITY settings from 50 MV/CM through 20 VOLTS/CM, AMPLIFIER

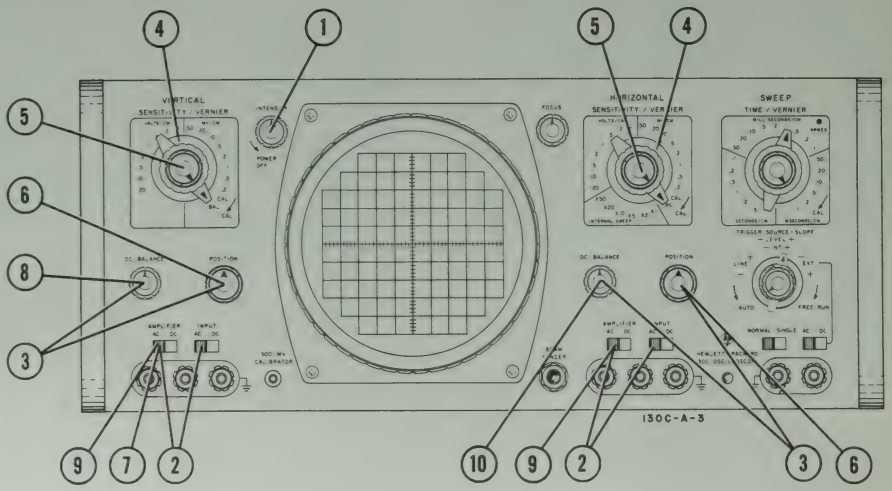
Table 3-2. Characteristics and Applications for AMPLIFIER and INPUT Coupling Combinations

AMPLIFIER	INPUT	SENSITIVITY (MV/CM) .2	.5	1	2	5	10	20	50 MV to 20 VOLTS/CM	APPLICATIONS
AC	DC	25 cps	10 cps	5 cps	2.5 cps	1 cps	.5 cps	.25 cps	DC	For observing the DC component of waveforms; typical drift 0.3 mv per half hour.
AC	AC	25 cps	16 cps	11 cps	← 10 cps →					For observing small, low-frequency components of waveforms without drift (AMPLIFIER switch has no effect on V/CM ranges)
DC	AC	← 10 cps →								For general-purpose measurement of AC waveforms; blocks DC components; maximum input is 600 volts peak (AC + DC)
DC	DC	← DC →								For observing very low frequency components at high sensitivities when large DC level is present. (Note maximum input limit)

coupling switch has no effect; coupling is always DC for these ranges. When using amplifier AC coupling in the most sensitive range of 0.2 MV/CM at low ambient temperatures the amplifier sensitivity is reduced slightly. The reduction is noticeable only at temperatures below 25°C and reaches a maximum of approximately 3% at 0°C.

3-33. APPLYING INPUT SIGNALS.

3-34. For measurements at high amplifier sensitivities and high impedance levels a shielded input connection to the Oscilloscope is desirable. The Model 10111A Adapter provides a shielded banana post to female BNC connector. Two adapters can be used to provide shielded connections for differential input operation. Frequency compensated divider probes (listed in Table 1-2) can be used to provide a higher input impedance and thus reduce loading effects on the circuit where measurements are made. The 500 MV CALIBRATOR output on the Model 130C front panel may be used for probe compensation adjustment (described in the Operating Note for the probe). The Model 10111A Adapter is necessary for connecting the divider probes to the Model 130C input terminals.



Note

Steps 2 through 6 are for both horizontal and vertical controls.

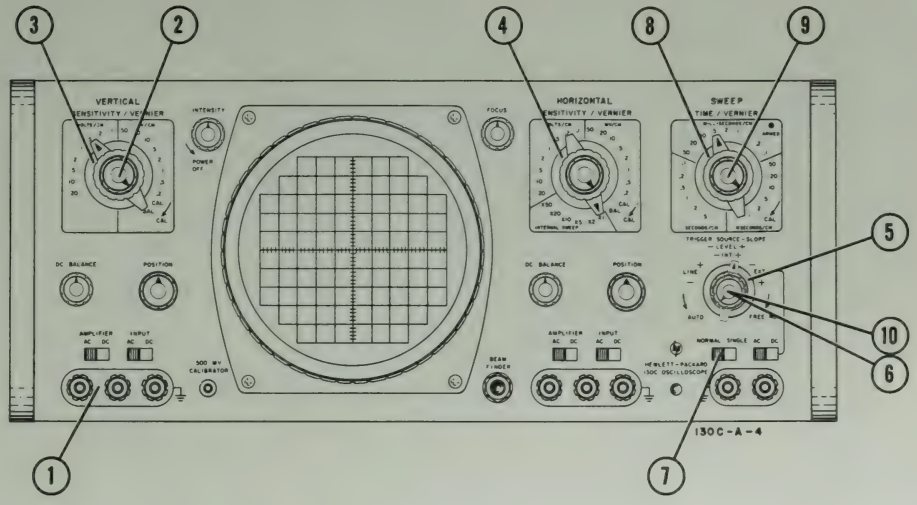
1. Set INTENSITY to mid-range.
2. Set AMPLIFIER and INPUT to AC.
3. Set DC BALANCE and POSITION to mid-range.
4. Set SENSITIVITY to BAL.
5. Set VERNIER to CAL.
6. Center spot with POSITION.
7. Set vertical AMPLIFIER to DC.
8. Center spot with vertical DC BALANCE. If spot is not on CRT, depress BEAM FINDER, and set DC BALANCE so spot is about centered on CRT. Release BEAM FINDER and if necessary, refine DC BALANCE setting so spot is centered on CRT (spot will always travel up and down near the vertical center graticule line). Vertical amplifier is now DC Balanced.

Note

If spot cannot be centered with DC BALANCE at about its mid-range, check the coarse balance adjustment (internal) according to Section V procedure.

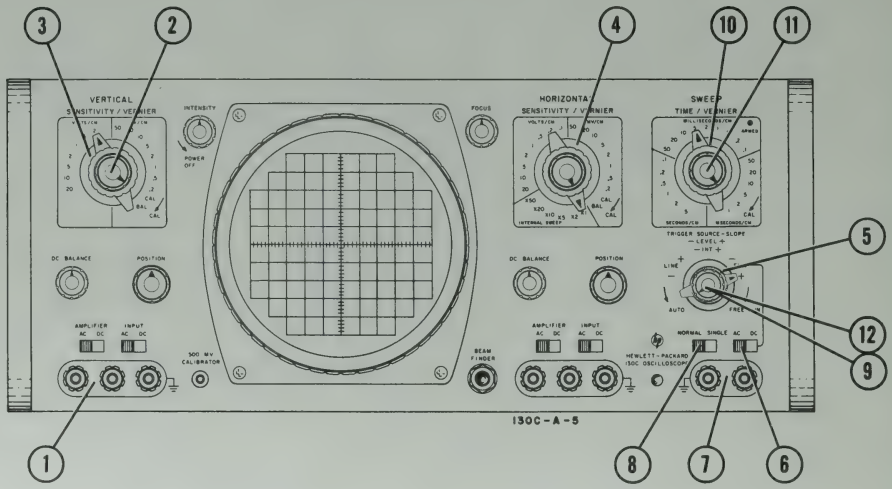
9. To balance the horizontal amplifier first set vertical AMPLIFIER to AC and horizontal AMPLIFIER to DC.
10. Center spot with horizontal DC BALANCE. If spot is not on CRT, depress BEAM FINDER, and set DC BALANCE so spot is about centered on CRT. Release BEAM FINDER and if necessary, refine DC BALANCE setting so spot is centered on CRT (spot will always travel across CRT near the horizontal center graticule line). Horizontal amplifier is now DC balanced. See note following step 8, this procedure.

Figure 3-3. DC BALANCE Procedure



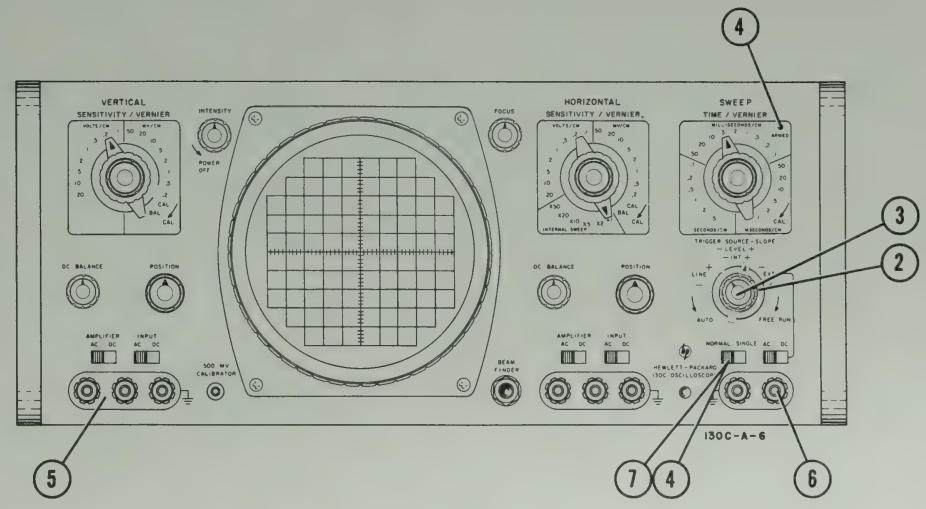
1. Connect vertical signal to input. For differential input see Figure 3-7.
2. Set SENSITIVITY for desired vertical deflection.
3. Set VERNIER to CAL for calibrated sensitivity.
4. Set SENSITIVITY to INTERNAL SWEEP X1.
5. Set TRIGGER SOURCE-SLOPE to INT + or INT -. To trigger on power line waveforms set TRIGGER SOURCE-SLOPE to LINE + or LINE -.
6. Set LEVEL to AUTO.
7. Set NORMAL-SINGLE to NORMAL.
8. Set SWEEP TIME for desired presentation of waveform.
9. Set VERNIER to CAL for calibrated sweep time.
10. Adjust LEVEL to trigger at a desired point on triggering waveform.

Figure 3-4. Internal Sweep with Internal Trigger



1. Connect vertical signal to input.
2. Set SENSITIVITY for desired vertical deflection.
3. Set VERNIER to CAL for calibrated sensitivity.
4. Set SENSITIVITY to INTERNAL SWEEP X1.
5. Set TRIGGER SOURCE-SLOPE to EXT + or EXT -.
6. Set AC-DC to either AC or DC for trigger signal above 20 cps; set to DC for trigger signal from DC to 20 cps.
7. Connect trigger signal to input.
8. Set NORMAL-SINGLE to NORMAL.
9. Adjust LEVEL to obtain a display on CRT. Do not use AUTO for trigger below 50 cps.
10. Set SWEEP TIME for desired presentation of waveform.
11. Set VERNIER to CAL for calibrated sweep time.
12. Adjust LEVEL to trigger at desired point on triggering waveform.

Figure 3-5. Internal Sweep with External Trigger



1. Set SENSITIVITY and SWEEP TIME as desired.

2. Set TRIGGER SOURCE-SLOPE for internal or external triggering as required.

3. Set LEVEL to proper triggering point. Do not use AUTO or FREE RUN (see Paragraph 3-12).

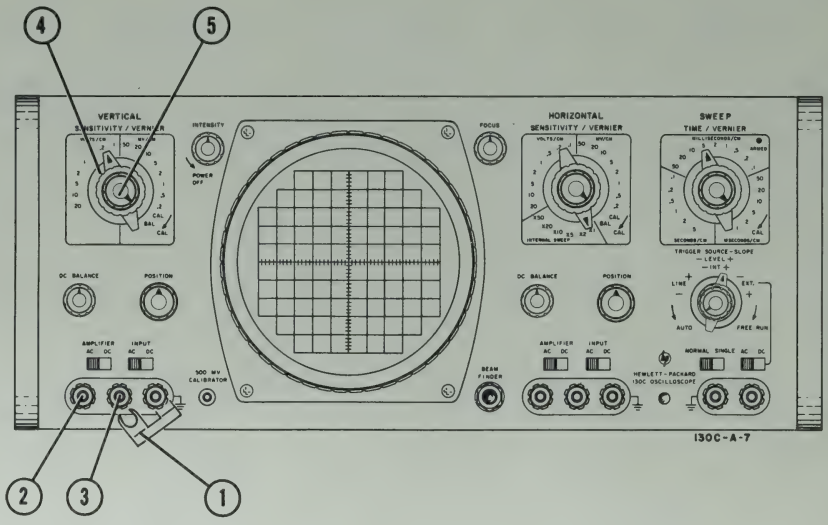
4. Set NORMAL-SINGLE to SINGLE. ARMED indicator should glow.

5. Apply vertical signal.

6. Apply trigger signal if required (i.e. if using external trigger; otherwise sweep will trigger internally from vertical circuits).

7. To re-arm sweep, switch to NORMAL and back to SINGLE. ARMED indicator will glow when sweep is armed and ready to be triggered.

Figure 3-6. Single Sweep Operation



1. Disconnect grounding link from center input terminal.

2. Connect positive-going signal to left-hand terminal.

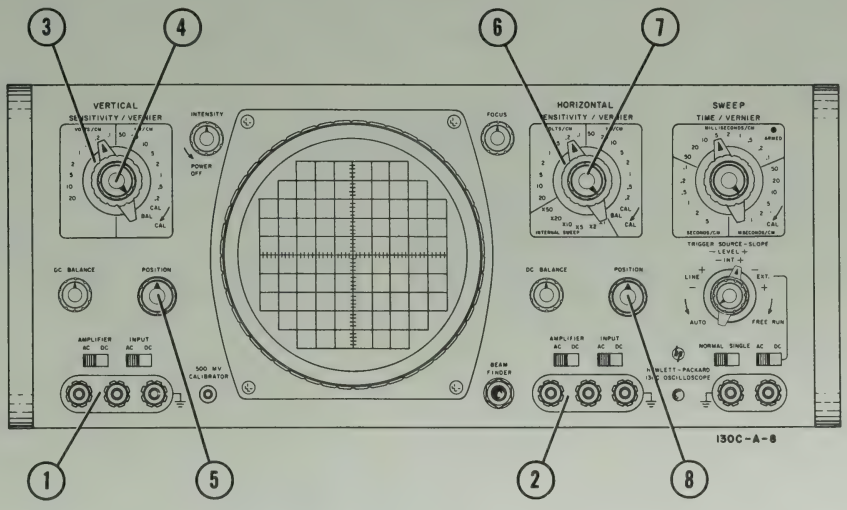
3. Connect negative-going signal to center terminal.

4. Set SENSITIVITY for desired vertical deflection. When using high sensitivities (i.e. toward 0.2 MV/CM) and internal DC coupling, check for DC BALANCE (Figure 3-3) if necessary.

5. Set VERNIER to CAL for calibrated sensitivity.

6. Follow the procedure above if differential horizontal input is desired.

Figure 3-7. Differential Operation



1. Connect Y signal to vertical input.

2. Connect X signal to horizontal input.

3. Set SENSITIVITY for desired deflection.

4. Set VERNIER to CAL for calibrated sensitivity.

5. Adjust POSITION for desired vertical position.

6. Set SENSITIVITY for desired deflection.

7. Set VERNIER to CAL for calibrated sensitivity.

8. Adjust POSITION for desired horizontal position.

Figure 3-8. X-Y Operation

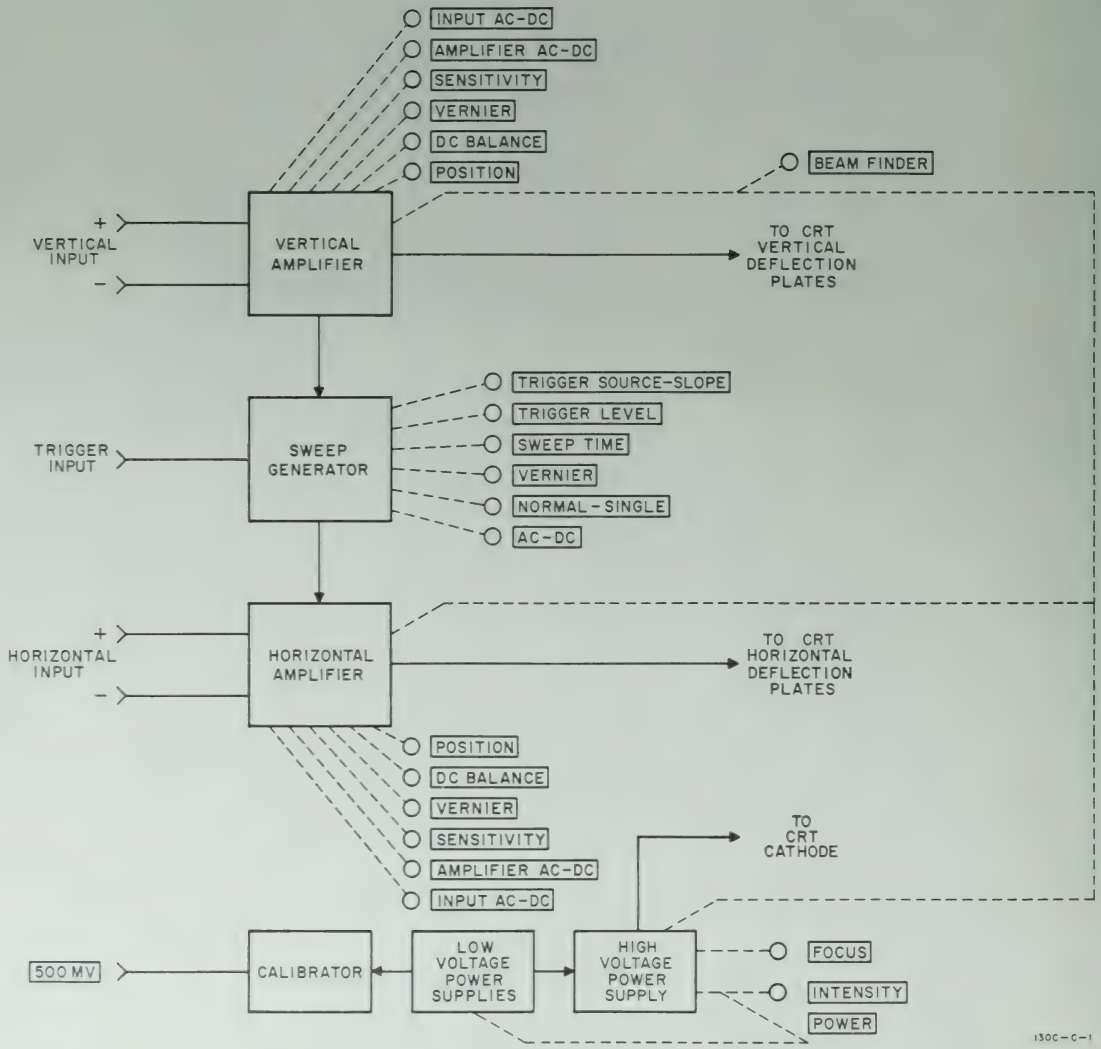


Figure 4-1. Model 130C Overall Functional Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. As shown in the block diagram, Figure 4-1, the Model 130C consists of five major sections: low voltage power supply, high voltage power supply, vertical amplifier, horizontal amplifier and sweep generator.

4-3. The paragraphs of this section discuss the circuit details of the major sections of the Model 130C. Since the vertical and horizontal amplifiers are nearly identical, the horizontal amplifier is described where it differs from the vertical amplifier.

4-4. LOW VOLTAGE POWER SUPPLY.

4-5. The low voltage power supply provides operating voltages for the amplifiers and for the sweep generator circuits with outputs of -100V, +12.5V, +100V, and +250V. The regulated +12.5 volt supply provides filament voltage for the vertical and horizontal input stages and a current source for the trace alignment coil.

4-6. -100 VOLT SUPPLY.

4-7. The -100 volt supply provides regulated voltages for the amplifier and sweep circuits, and also provides a reference voltage for the +100 volt and +250 volt supplies. Refer to Figure 4-2. Differential Amplifier Q463/Q464 compares the reference voltage from Reference Tube V461 against the output voltage sample obtained by voltage divider R467/R469. The difference voltage is amplified and applied to Driver Q462 and Series Regulator Q461. The voltage applied to Series Regulator Q461 is out of phase, i.e., when the output voltage of the supply rises, the voltage applied to Q461 causes the series voltage drop to increase, returning the supply voltage to its original level. In this way, any variations in output voltage due to load change or line voltage change are sensed by the differential amplifier and corrected by the series regulator. Potentiometer R468 adjusts the output voltage to exactly -100 volts.

4-8. +100 and +250 VOLT SUPPLIES.

4-9. The +100 and +250 volt supplies operate in the same manner as the -100 volt supply. A sample of the output voltage is compared to a reference voltage (the -100 volt supply) and the difference voltage amplified and applied to a series regulator. The series regulator corrects for the variations in output voltage. The +250 volt is "stacked" on the +100V supply and the two are interdependent.

4-10. +12.5 VOLT SUPPLY.

4-11. The +12.5 volt supply is dependent only on the -100V supply and uses a single series regulator Q481 with a Zener diode reference CR482. Any variation in supply voltage is coupled through the reference diode. This results in a base current change for Q481, which is amplified and acts to vary the supply load current, providing the supply regulation.

4-12. HIGH VOLTAGE POWER SUPPLY.

4-13. The high voltage power supply provides the voltages necessary for the operation of the cathode ray tube. Refer to Figure 4-3 for the following explanation. Tube V301 is operating in a Hartley oscillator circuit, oscillating at approximately 70 kc. The oscillator voltage is applied to the primary of high voltage transformer T301. The primary voltage is stepped up by the transformer and rectified by V304 and V305. The output of the rectifiers is filtered and applied to the CRT cathode and grid. The CRT cathode voltage is compared to the +250V supply by voltage dividers R311 through R318 and applied to Control Amplifier V302. Since the cathode of V302 is

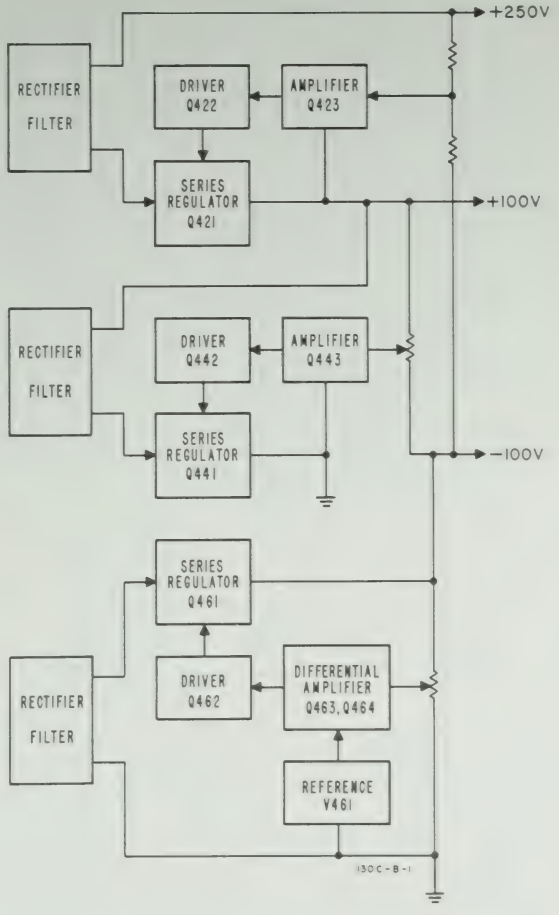


Figure 4-2. LV Power Supply Block Diagram

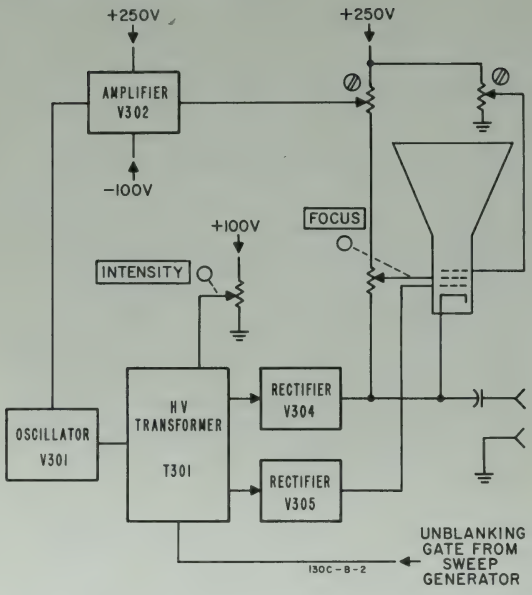


Figure 4-3. H V Power Supply Block Diagram

tied to a regulated voltage (-100 volts) any variation in high voltage is seen by V302 as a change in grid-cathode voltage. This grid-cathode voltage change is amplified and applied to the screen grid of Oscillator V301 to control the output amplitude of the oscillator. The change is always in the proper direction to correct for change in high voltage.

4-14. INTENSITY control R308 varies the CRT cathode voltage, varying the intensity of the spot or trace on the CRT screen. FOCUS control R317 varies the focus grid voltage for trace focus. Astigmatism adjustment R319 varies the voltage on the accelerator to adjust beam geometry for a round spot.

4-15. SWEEP GENERATOR.

4-16. Refer to Figure 4-4 for a block diagram of the sweep generator circuitry. The trigger generator produces signals which synchronize the sweep with internal signals from the vertical amplifier or power line, or with external trigger signals. In Figure 4-4 circuits represented in blocks to the right of the Trigger Generator produce a linear sweep voltage (sawtooth wave shape) which is amplified by the horizontal amplifier and applied to the CRT deflection plates.

4-17. TRIGGER GENERATOR.

4-18. The trigger generator consists of differential amplifier V101 and Schmitt trigger V102. The trigger

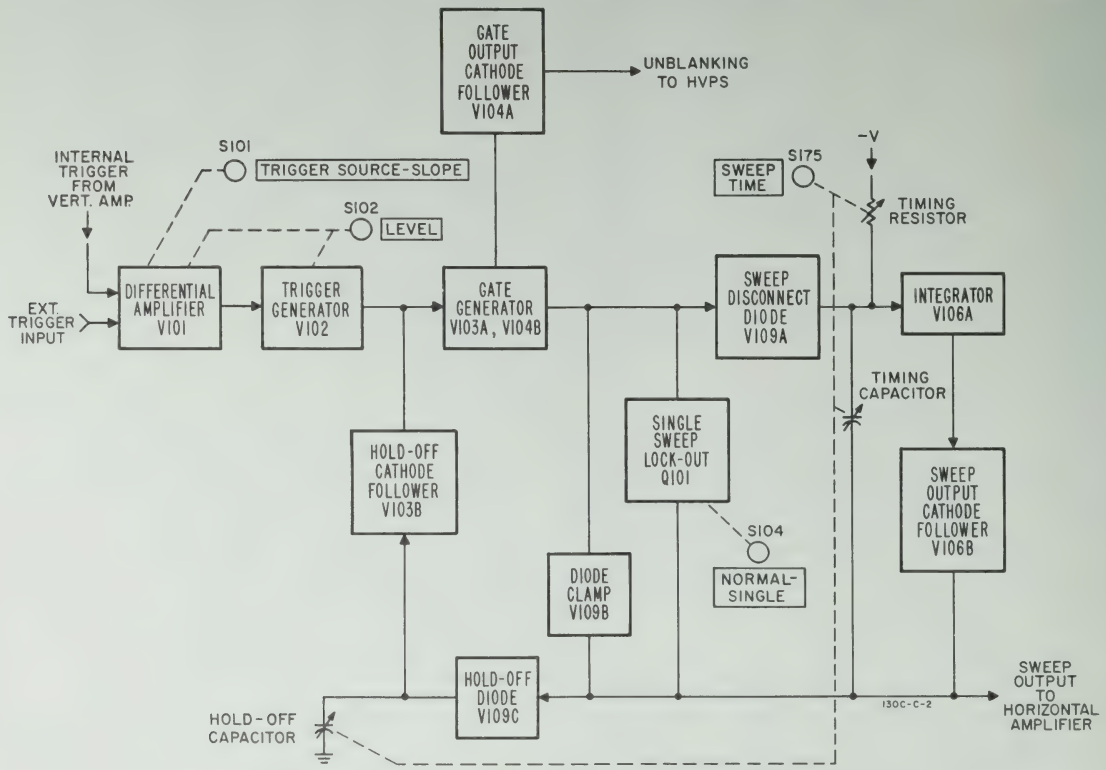


Figure 4-4. Sweep Generator Functional Block Diagram

signal, whether power line, internal, or external, is applied to one grid of V101 as determined by setting of the trigger slope control (S101). The other grid is connected to LEVEL control R116 through S101. The setting of R116 determines the DC level on one half of V101, and thus the point at which the trigger signal will cause V101 to conduct. The output of V101B drives trigger generator V102 which provides the waveform to drive the gate generator. When S102 is in FREE RUN no trigger is needed to switch the gate generator to start a new sweep; see Paragraph 4-26. When S102 is in AUTO, trigger generator V102 is converted to a free-running multivibrator (R124 is placed in circuit by S102C), with a repetition rate of 40 to 50 cps. Switch section S102B grounds one grid of V101 (depending on slope selected by S101) and AC-couples the trigger signal through C113 to V102A. This arrangement allows the trigger to be generated at the approximate zero crossing of the input signal.

4-19. GATE GENERATOR.

4-20. The square wave generated by V102 is differentiated by C115 and R130, and the positive spike is clipped by CR111. Gate Generator V103A and V104B operates as a Schmitt Trigger circuit with wide hysteresis limits. The negative spike, through C116 to the grid of V103A, causes the gate generator to change states, starting the sweep. As the gate generator switches states, the positive output at V103A plate goes to cathode follower V104A which provides the unblanking signal to the CRT (through the HV power supply).

4-21. INTEGRATOR.

4-22. As the gate generator changes stages (on signal from the trigger generator), the negative gate voltage at V104B takes diodes V109A and V109B out of conduction. This allows the timing capacitor (C175 through C181, depending on sweep time set) to charge in a negative direction, since it is connected through the sweep time resistors to -100 volts. The integrator V106A amplifies and inverts this negative-going voltage at its grid (pin 2) to produce a large, positive-going output at the plate. This positive-going voltage is fed back to V106A grid through cathode follower V106B and the timing capacitor and this feedback keeps the integrator input voltage almost constant. Thus the voltage across the sweep timing resistor also remains nearly constant to produce a corresponding nearly constant current. The current charges the sweep capacitor at a linear rate to produce a linear sweep output. The sweep output is routed through switch S202 to the horizontal amplifier and then to the CRT deflection plates.

4-23. The slope of the sweep output waveforms is determined by the RC time constant of resistors (R175 to R186) and capacitors (C175 to C181) used on a selected SWEEP TIME range. VERNIER control R179 provides a fine adjustment of sweep time by altering the DC voltage to which the timing resistor is returned. Neon lamp V107 is used to reduce the average level of the sawtooth swing to a less positive value so the lower end of the sweep may be clamped to zero volts.

4-24. SWEEP TERMINATION AND HOLD-OFF.

4-25. Termination of a sweep is accomplished by feeding back the positive-going sweep voltage to the input of the gate generator. The feedback path is through hold-off diode V109C (which conducts during the sweep) and hold-off cathode follower V103B. The feedback voltage on V103B grid causes the cathode voltage to cross the upper hysteresis limit of the gate generator. The time required for this feedback to reach the upper hysteresis limit is determined by the sawtooth slope, thus setting the time between sweeps. The gate generator changes state to produce a negative voltage step at the plate of V103A and a positive voltage step at the plate of V104B. The negative voltage step is fed through gate output cathode follower V104A to the high-voltage power supply, blanking the CRT beam until a new sweep begins. The positive voltage step at the plate of V104B causes diodes V109A and V109B to conduct. The sweep timing capacitor discharges quickly through the clamp diode V109B, clamping the sweep output to a constant level and producing the retrace portion of the sweep waveform. The two diodes return the sweep output to the same reference level as the grid of integrator V106A. Hold-off diode V109C is cut off by the fast negative drop of the retrace (i.e., as timing capacitor discharges), but instead of a rapid decrease in voltage at the grid of V103B, the voltage here starts decaying at a rate determined by R148 and the value of hold-off capacitor used on a given sweep range. The cathode of V103B follows this decay rate and V103A grid voltage is kept high enough for a sufficient time to allow sweep circuit recovery. When the hold-off level from V103B decays enough, a negative trigger at V103A grid can reach the lower hysteresis limit and begin a new sweep cycle. Stability adjustment, R151, sets the DC level (just above lower hysteresis limit) at which V103B cathode quits following the hold-off decay voltage on the grid (this circuit is changed in free run operation; see Paragraph 4-26). An incoming trigger which reaches below this DC level to the lower hysteresis limit, starts the new sweep.

Note

The hold-off capacitor for a given sweep time setting is the same capacitor which is used as the timing capacitor in another sweep range (except that stray capacitance is used for hold-off purposes in the three fastest sweep speeds). For example, C176 is the hold-off capacitor in 0.1 through 5 SECOND/CM settings, but then C176 becomes the timing capacitor in 10, 20, and 50 MILLISECONDS/CM settings (and C177 becomes the hold-off capacitor).

4-26. FREE RUN CIRCUIT OPERATION.

4-27. When LEVEL control is set to FREE RUN, the gate generator and other sweep circuits operate without a trigger from V102. This is accomplished by allowing the hold-off decay at V103B cathode to cross the lower hysteresis limit (rather than a trigger crossing as explained in Paragraph 4-24) of the gate generator which initiates a new sweep cycle. The stability adjustment is switched out of the circuit by S102E which applies -100 volts directly to R152 in the

cathode circuit of V103B. This shifts the DC level at which V103B cathode quits following the grid hold-off voltage to a level below the lower hysteresis limit. Now as the hold-off decay voltage crosses the hysteresis limit it starts the sweep again.

4-28. SINGLE SWEEP CIRCUIT.

4-29. In single sweep operation the sweep is triggered on the first trigger received after manual arming, and further triggers are ineffective until the circuit is re-armed. This sequence is accomplished in the Model 130C by preventing the retrace from occurring. In NORMAL operation, switch S104A returns Q101 emitter to ground through R150 and the transistor is inoperative. In SINGLE operation, however, S104A connects R150 to -100 volts. This still biases Q101 off, but allows conduction when the base voltage becomes more positive during the sweep. In the SINGLE position, S104B connects +100v to neon indicator DS101. Because the sweep level is at zero volts before the sweep waveform begins, there is sufficient voltage across the neon to cause it to light (ARMED). Assuming that S104 has just been switched to SINGLE position, the first trigger to arrive at the gate generator starts a sweep in the usual way. As the sweep output voltage rises, the voltage across DS101 decreases until the light goes out. The positive-going sweep voltage is also applied by voltage divider R143 and R144 to the base of Q101, bringing the transistor into conduction and eventually driving it into saturation. As in NORMAL operation, the sweep voltage is fed back through the hold-off circuit to switch the gate generator back to its pre-sweep condition (V103A on, V104B off). With V104B cut off, the saturation current of Q101 flowing through R137 is still enough to keep diodes V109A and V109B biased off. Integrator V106A is thus allowed to continue integrating until it reaches saturation. The sweep output waveform rounds and levels off, remaining at this high positive level until the circuit is manually re-armed. Since this positive voltage is fed back through the hold-off circuit to the input of the gate generator, triggers generated by V102 are unable to overcome this voltage and operate the gate. To re-arm the circuit, S104 is switched back to NORMAL. This cuts off Q101, which allows V109A and V109B to conduct and return the integrator to its pre-sweep condition. Setting switch S104 back to SINGLE will repeat the single sweep operation.

4-30. VERTICAL AMPLIFIER.

4-31. The vertical amplifier, as shown in the block diagram of Figure 4-5, consists of three basic sections: (1) input attenuators, (2) differential feedback amplifier, and (3) output differential amplifier. These circuits are explained in detail in Paragraphs 4-32, 4-34, and 4-36.

4-32. INPUT ATTENUATOR.

4-33. The input attenuator consists of two identical frequency-compensated voltage dividers which provide a constant input impedance of 1 megohm shunted by 45 pf on all ranges of SENSITIVITY for both + and - inputs. Switch S2 selects either capacitive (AC) or direct (DC) coupling from the input terminals to the attenuator. Capacitors C21 and C22 are used to adjust input capacitance to 45 pf on SENSITIVITY ranges 0.2 MILLIVOLTS/CM to 0.2 VOLTS/CM. A division

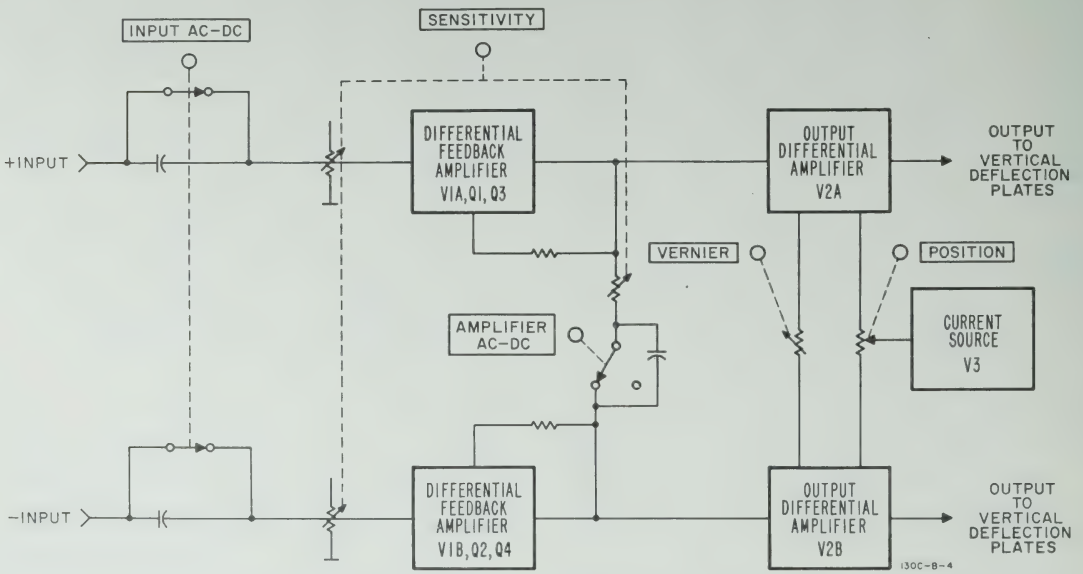


Figure 4-5. Vertical Amplifier Functional Block Diagram

ratio of 100:1 on the three least sensitive ranges (5 VOLTS/CM to 20 VOLTS/CM) is provided by R11/R13 and R12/R14 on the two inputs. Capacitors C11 and C12 maintain the ratio at high frequencies by capacitive division. Capacitors C13 and C14 are adjusted for 45 pf input capacitance on the three least sensitive ranges. A division ratio of 10:1 on the next three ranges (0.5 VOLTS/CM to 2 VOLTS/CM) is provided by R15/R17 and R16/R18 on the two inputs. Capacitors C17 and C18 maintain this ratio at high frequencies and C19 and C20 are adjusted to keep input capacitance at 45 pf on these three ranges. In the CAL. position of the SENSITIVITY switch, input terminals are opened and a 5 millivolt, ±3%, 350 cps square wave is applied to the input of tube V1A to check amplifier calibration. Sensitivity of the amplifier in the CAL. position is 1 mv/cm. In BAL. position, the input terminals are opened and the grid circuits of V1 are grounded to allow accurate balancing of DC voltages in the amplifier.

4-34. DIFFERENTIAL FEEDBACK AMPLIFIER.

4-35. From the input attenuator, a signal is fed to the input of the differential feedback amplifier, i.e. grids of V1. Resistors R41 and R42 provide input overload protection. The gain of this amplifier (consisting of V1, and Q1 through Q4) is effectively controlled by the interstage attenuator which inserts feedback resistance (determined by S1 setting) between the emitters of Q3 and Q4. Gain is proportional to the ratio of the third-state (Q3 and Q4) collector load to feedback resistance. The interstage attenuator and the input attenuator give the overall control of deflection sensitivity. The main DC current path for both V1 and Vernier Bal adjustment is through the feedback paths, R40-R50 or R48, to the -100 volt supply at the collectors of Q3 and Q4. The positive voltage supply with high value resistors (compared to feedback resistance) used for Vernier Bal, minimizes the effect of balance adjustments on gain. Vernier Bal is adjusted to offset any unbalance at the output stage plates resulting from the change in resistance between the cathodes of V2A and V2B when VERNIER is rotated out of CAL position. DC BALANCE, R49, and Coarse DC Bal, R48, adjustments are used to equalize the voltage on either side of the feedback resistance. When the voltages are balanced, the feedback resistors have no DC flowing through them and thus changing their values has no effect on amplifier balance. The AMPLIFIER AC-DC switch allows capacitive coupling of the interstage attenuator on the seven most sensitive ranges, minimizing the effect of DC drift by preventing DC current flow in the feedback resistors. The result is the same as if the amplifier is balanced. Gain adjustment R69 functions in the same manner as VERNIER control R70, by inserting resistance which acts as degenerative feedback. Thus the gain may be controlled in order to bring the sensitivity calibration into agreement with a voltage standard or to set intermediate sensitivities. The output of the differential feedback amplifier at Q3 and Q4 collectors drives the output differential amplifier, V2A and V2B.

4-36. OUTPUT AMPLIFIER.

4-37. The output differential amplifier, V2A and V2B, provides the voltage swing necessary to drive the deflection plates of the CRT. Cross-neutralization of the output stages is accomplished by adjustable capacitors C48 and C49 (shunted by C53), which couple in-phase signals from the plates of the tubes to the opposite grids. A voltage divider consisting of R75 and R77 in the plate circuit of V2A divides the output signal for use as an internal synchronizing signal for the sweep generator. Constant current source V3 is an active impedance, functioning as a high common cathode impedance to achieve high differential gain without the use of a large cathode resistor and negative supply. There are two front panel variable controls in the output amplifier: SENSITIVITY VERNIER and POSITION. When rotated ccw VERNIER, R70, decreases the gain (i.e. reduces sensitivity) of the amplifier by introducing degeneration in the cathode of V2. Vertical movement of the trace is accomplished by POSITION, R78, which feeds back differential currents through R73 and R74. This results in a differential change in Q3 and Q4 collector currents and a differential voltage change at the grids of V2. Resistors R79 and R80 insure that regardless of the POSITION setting, no DC voltage change occurs at the cathodes of V2 as VERNIER is moved. Thus, position of the trace is not affected by changes in the SENSITIVITY VERNIER.

4-38. BEAM FINDER switch S4 inserts R85 in the cathode of V3, reducing the current available to the output stage. This reduces the voltage swing of V2 and reduces the CRT deflection plate voltage swing, which brings the trace on screen regardless of signal amplitude.

4-39. HORIZONTAL AMPLIFIER.

4-40. The horizontal amplifier circuit operation is identical to that of the vertical amplifier except for the internal sweep positions of the SENSITIVITY switch, and the POSITION control R221A/B. In the INTERNAL SWEEP positions, X1 through X50, the sawtooth voltage output from the sweep generator is coupled into the amplifier input at V201A. The sweep signal gain is then controlled by the interstage attenuator (see Figure 5-16) and applied to the CRT deflection plates. To allow viewing of any portion of an expanded waveform, a greater range for POSITION control is obtained by varying the DC level at the amplifier input where the sweep is applied. For internal sweep, R221B is switched out of the circuit and replaced by two fixed resistors, R273 and R274; VERNIER R264 is also shorted out leaving V202 cathodes tied together. Resistor R221A (and its voltage divider circuit) becomes the POSITION control and changes the DC level at which the sweep waveform is applied to the amplifier. Then as amplifier gain is increased by the interstage attenuator section of S202, the sweep is expanded and the effective positioning range is increased at the same time.

Table 5-1. Required Test Equipment

Item	Instrument Type	Required Characteristics	Measurement/Adjustment	Ref Para	Recommended Instruments
1	Voltmeter Calibrator	Output: 0.002 to 300V p-p	Vert. Sensitivity Ext. Calibrator Vert. Calibrator Horiz. Sensitivity Horiz. Calibrator Vert. Gain Horiz. Gain	5-7 5-8 5-9 5-12 5-13 5-75 5-75	℗ Model 738AR (CAQI-738-A*)
2	Oscillator	Frequency: 10 cps to 500 kc	Vert. Bandwidth Vert. Common Mode Rej. Horiz. Bandwidth Horiz. Common Mode Rej. Phase Shift Triggering Trigger Point Intensity Mod. Horiz. Neut Input Cap and Freq. Comp. Sweep Length	5-10 5-11 5-14 5-15 5-16 5-17 5-18 5-22 5-76 5-77 5-85	℗ Model 200CD (AN/URM-127*)
3	Attenuator	0 to 110 db attenuation	Vert. Bandwidth Horiz. Bandwidth Phase Shift	5-10 5-14 5-16	℗ Model 350D
4	AC Voltmeter	Range: 3 mv f.s.	Vert. Bandwidth Horiz. Bandwidth	5-10 5-14	℗ Model 400D
5	Time Mark Generator	Marker Internal: 1 usec to 5 sec in 1, 2, 5, 10 sequence Output: greater than 0.1 mv p-p	Sweep Calib. Sweep Magnifier Sweep Time Calib.	5-19 5-21 5-86	Tektronix Type 180A (AN/USM-108*)
6	DC Voltmeter	Range: 0 to 300v f.s. Accuracy: ± 1%	LV Power Supply Vert. Output Stage Current Horiz. Output Stage Current Sweep Stability	5-65 5-74 5-74 5-84	℗ Model 412A (CAQI-412*)
7	HV DC Voltmeter	Range: 0 to 3 kv f.s. Accuracy: ± 3%	HV Power Supply	5-67	℗ Model 11044A Voltage Divider with ℗ Model 410B/C (AN/USM-116*), adjusted to ± 3% accuracy
8	Square Wave Generator	Frequency: 10 kc and 50 kc Output: 0 to 55V p-p	Vert. Neut. Vert. Atten. Comp. Horiz. Neut. Horiz. Atten. Comp.	5-76 5-77 5-76 5-77	℗ Model 211A (TS-583B/U*)
9	L-C Meter or Alignment Attenuator	Range: 40 to 50 pf	Vert. Input Cap. Horiz. Input Cap.	5-77 5-77	Tektronix Type 130 (AN/URM-90*) or ℗ Model 10403A

* Designation for Military Preferred Instrument

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information for the adjustment and repair of the Model 130C. Also included are step-by-step procedures for checking performance against the specifications.

5-3. PERFORMANCE CHECK.

5-4. GENERAL.

5-5. This performance check may be used as a routine maintenance procedure or as an incoming inspection to verify the performance of the instrument. The instruments required for the performance check are items 1 through 5 listed in Tables 5-1. If the recommended equipment is not available, equipment with similar characteristics may be substituted.

5-6. PRELIMINARY PROCEDURE.

a. Set controls as follows:

INTENSITY · · · · · · · · · · Mid Range
All AC-DC switches · · · · · · · · · · AC
All VERNIERS · · · · · · · · · · · Cal.
VERTICAL SENSITIVITY · · · 20VOLTS/CM
HORIZONTAL SENSITIVITY · INTERNAL SWEEP X1
SWEEP TIME · · · · 1 MILLISECONDS/CM
TRIGGER SOURCE-SLOPE · · · · · · INT+
LEVEL · · · · · · · · · · · · FREE RUN
NORMAL-SINGLE · · · · · · · NORMAL
POSITION Controls · · · · · · · Centered

b. A trace should appear on the screen. Adjust INTENSITY if necessary.

c. Rotate INTENSITY through its range. The trace brightness should vary from extinguished to brighter than normal. Adjust INTENSITY for normal viewing level.

d. Rotate FOCUS through its range. The trace should be defocused at each extreme of the control and focused at midrange. Adjust FOCUS for sharpest trace.

e. Adjust TRACE ALIGN (rear panel) to align the trace parallel to the horizontal graticule lines.

f. Adjust POSITION controls to remove trace from screen. Turn INTENSITY counterclockwise. Depressing BEAM FINDER should return trace to screen.

5-7. VERTICAL SENSITIVITY.

a. Apply a 1 volt p-p signal from the Voltmeter calibrator to the vertical input.

b. Set: Vertical SENSITIVITY · · 0.1 VOLTS/CM
Vertical VERNIER · · · · · · · · CAL
Vertical INPUT · · · · · · · · · DC

c. Vertical deflection should be between 9.7 and 10.3 cm.

d. Check all other SENSITIVITY ranges in the same manner as above, using the values shown in Table 5-2. The deflection in each case should be between 9.7 and 10.3 cm.

e. Disconnect the grounding link from the center input terminal.

f. Set: Vertical SENSITIVITY · · 1 VOLTS/CM
Voltmeter Calibrator output · 10 volts p-p

g. Connect the Voltmeter Calibrator between the center terminal and the ground terminal.

h. Connect the left-hand input terminal to ground.

i. The deflection should be between 9.7 and 10.3 cm.

j. Set: Vertical SENSITIVITY · ·10 VOLTS/CM
Voltmeter Calibrator output · 100 volts p-p

k. The deflection should be between 9.7 and 10.3 cm.

m. Disconnect the Voltmeter Calibrator. Reconnect the grounding link.

5-8. EXTERNAL CALIBRATOR.

a. Connect the Voltmeter Calibrator to the Vertical input.

b. Set: Vertical INPUT · · · · · · · · DC
Vertical SENSITIVITY · · · 20 MV/CM
Voltmeter Calibrator Output · 0.5v p-p

Table 5-2. Vertical/Horizontal Sensitivity Calibration

SENSITIVITY	Calibrator Output	Deflection
.2 MV/CM	.002 v	9.7 to 10.3 cm
.5 MV/CM	.005 v	9.7 to 10.3 cm
1 MV/CM	.01 v	9.7 to 10.3 cm
2 MV/CM	.02 v	9.7 to 10.3 cm
5 MV/CM	.05 v	9.7 to 10.3 cm
10 MV/CM	.1 v	9.7 to 10.3 cm
20 MV/CM	.2 v	9.7 to 10.3 cm
50 MV/CM	.5 v	9.7 to 10.3 cm
.1 VOLTS/CM	1 v	9.7 to 10.3 cm
.2 VOLTS/CM	2 v	9.7 to 10.3 cm
.5 VOLTS/CM	5 v	9.7 to 10.3 cm
1 VOLTS/CM	10 v	9.7 to 10.3 cm
2 VOLTS/CM	20 v	9.7 to 10.3 cm
5 VOLTS/CM	50 v	9.7 to 10.3 cm
10 VOLTS/CM	100 v	9.7 to 10.3 cm
20 VOLTS/CM	200 v	9.7 to 10.3 cm

c. Adjust Vertical VERNIER for exactly 10 cm deflection.

d. Disconnect Voltmeter Calibrator and apply signal from 500 MV CALIBRATOR to vertical input.

e. Deflection should be between 9.8 and 10.2 cm.

f. Disconnect the calibrator signal.

5-9. VERTICAL CALIBRATOR.

a. Set: Vertical SENSITIVITY . . . 1 MV/CM
Voltmeter Calibrator output . 5 mv p-p

b. Adjust vertical VERNIER for exactly 4 cm deflection.

c. Set vertical SENSITIVITY to CAL.

d. The deflection should be between 3.88 and 4.12 cm.

e. Disconnect the Voltmeter Calibrator.

5-10. VERTICAL BANDWIDTH.

a. Set: Vertical SENSITIVITY . . . 1 MV/CM
Vertical VERNIER . . . . . CAL

b. Connect the Oscillator to the vertical input.

Note

External attenuation of the Oscillator signal is required for this check. Use a HP Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.

c. Set Oscillator frequency to 5 kc.

d. Adjust Oscillator amplitude for 10 cm deflection.

e. Connect the AC Voltmeter in parallel with the vertical input.

f. Note reading of AC Voltmeter.

g. Change Oscillator frequency to 500 kc. Readjust amplitude for AC Voltmeter reading noted in step f, if necessary.

h. The deflection should be 7.1 cm or greater.

i. Disconnect the Oscillator and AC Voltmeter.

5-11. VERTICAL COMMON MODE REJECTION.

a. Set: Vertical SENSITIVITY . 0.2 VOLTS/CM
Vertical VERNIER . . . . . CAL

b. Disconnect the grounding link from the center vertical input terminal.

c. Connect the Oscillator between the center terminal and the ground terminal.

d. Connect a short jumper between the left-hand terminal and the ground terminal.

e. Set Oscillator frequency to 50 kc.

f. Adjust Oscillator amplitude for 10 cm deflection.

g. Short center and left-hand terminals with the jumper.

h. Set Vertical SENSITIVITY to 20 MV/CM.

i. The deflection should be 1 cm or less.

j. Set vertical SENSITIVITY to 1 VOLTS/CM.

k. Reconnect jumper between left-hand terminal and ground terminal.

m. Adjust Oscillator amplitude for 10 cm deflection.

n. Short center and left-hand terminals with the jumper.

p. Set vertical SENSITIVITY to 0.5 VOLTS/CM.

q. The deflection should be 0.6 cm or less.

r. Reconnect jumper between left-hand terminal and ground terminal.

s. Set vertical SENSITIVITY to 10 VOLTS/CM.

t. Adjust Oscilloscope amplitude for 5 cm deflection.

u. Short center and left-hand terminals with the jumper.

v. Set vertical SENSITIVITY to 5 VOLTS/CM.

w. The deflection should be 0.3 cm or less.

x. Disconnect the Oscillator. Reconnect the grounding link.

5-12. HORIZONTAL SENSITIVITY.

a. Apply a 1 volt p-p signal from the Voltmeter Calibrator to the horizontal input.

b. Set: Horizontal INPUT . . . . . DC
Horizontal SENSITIVITY 0.1 VOLTS/CM
Horizontal VERNIER . . . . . CAL

c. Horizontal deflection should be between 9.7 and 10.3 cm.

d. Check all other SENSITIVITY ranges in the same manner as above, using the values shown in Table 5-2. The deflection in each case should be between 9.7 and 10.3 cm.

e. Disconnect the grounding link from the center input terminal.

f. Set: Horizontal SENSITIVITY . 1 VOLTS/CM
Voltmeter Calibrator output . . 10v p-p

g. Connect the Voltmeter Calibrator between the center terminal and the ground terminal.

h. Connect the left-hand input terminal to ground.

i. The deflection should be between 9.7 and 10.3 cm.

j. Set: Horizontal SENSITIVITY . 10 VOLTS/CM
Voltmeter Calibrator output . . 10v p-p

k. The deflection should be between 9.7 and 10.3 cm.

m. Disconnect the Voltmeter Calibrator. Reconnect the grounding link.

5-13. HORIZONTAL CALIBRATOR.

a. Set: Horizontal SENSITIVITY . . 1 MV/CM
Voltmeter Calibrator output . 5 mv p-p

b. Adjust horizontal VERNIER for exactly 4 cm deflection.

c. Set horizontal SENSITIVITY to CAL.

d. The deflection should be between 3.88 and 4.12 cm.

e. Disconnect the Voltmeter Calibrator.

5-14. HORIZONTAL BANDWIDTH.

a. Set: Horizontal SENSITIVITY . . 1 MV/CM
Horizontal VERNIER . . . . . CAL

b. Connect the Oscillator to the horizontal input.

Note

External attenuation of the Oscillator signal is required for this check. Use a hp Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.

c. Set Oscillator frequency to 5 kc.

d. Adjust Oscillator amplitude for 10 cm deflection.

e. Connect the AC Voltmeter in parallel with the horizontal input.

f. Note reading of AC Voltmeter.

g. Change Oscillator frequency to 500 kc. Readjust amplitude for AC Voltmeter reading noted in step f, if necessary.

h. The deflection should be 7.1 cm or greater.

i. Disconnect the Oscillator and AC Voltmeter.

5-15. HORIZONTAL COMMON MODE REJECTION.

a. Set: Horizontal SENSITIVITY . 0.2 VOLTS/CM
Horizontal VERNIER . . . . . CAL

b. Disconnect the grounding link from the center horizontal input terminal.

c. Connect the Oscillator between the center terminal and the ground terminal.

d. Connect a short jumper between the left-hand terminal and the ground terminal.

e. Set Oscillator frequency to 50 kc.

f. Adjust Oscillator amplitude for 10 cm deflection.

g. Short center and left-hand terminals with the jumper.

h. Set horizontal SENSITIVITY to 20 MV/CM.

i. The deflection should be 1 cm or less.

j. Set horizontal SENSITIVITY to 1 VOLTS/CM.

k. Reconnect jumper between left-hand terminal and ground terminal.

m. Adjust Oscillator amplitude for 10 cm deflection.

n. Short center and left-hand terminals with the jumper.

p. Set horizontal SENSITIVITY to 0.5 VOLTS/CM.

q. The deflection should be 0.6 cm or less.

r. Reconnect jumper between left-hand terminal and ground terminal.

s. Set horizontal SENSITIVITY to 10 VOLTS/CM.

t. Adjust Oscillator amplitude for 5 cm deflection.

u. Short center and left-hand terminals with the jumper.

v. Set horizontal SENSITIVITY to 5 VOLTS/CM.

w. The deflection should be 0.3 cm or less.

x. Disconnect the Oscillator.

5-16. PHASE SHIFT.

a. Set: Horizontal and Vertical SENSITIVITY . .
. . . . . 10 VOLTS/CM
Horizontal and Vertical VERNIER . CAL
Horizontal and Vertical AMPLIFIER DC
Horizontal and Vertical INPUT . . DC

b. Connect the Oscillator to both horizontal and vertical input terminals.

c. Set Oscillator frequency to 100 kc.

d. Adjust Oscillator amplitude for 5 cm vertical and horizontal deflection.

e. The minor diameter of the ellipse should be less than 0.1 cm.

f. Check all other SENSITIVITY ranges, keeping deflection constant at 5 cm. The minor diameter of the ellipse should be less than 0.1 cm in each case.

Note

On the highest SENSITIVITY ranges, external attenuation of the Oscillator signal will be necessary. Use a hp Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.

g. Disconnect the Oscillator.

5-17. TRIGGERING.

a. Set: Vertical SENSITIVITY . . 20 VOLTS/CM
Horizontal SENSITIVITY . . . . . .
. . . . . INTERNAL SWEEP X1
SWEEP TIME . 1 MILLISECONDS/CM
TRIGGER SOURCE-SLOPE . . . EXT+
LEVEL . . . . . AUTO

b. A baseline should be displayed with no signal applied.

c. Apply a 500 kc signal from the Oscillator to the vertical input.

d. Set: TRIGGER SOURCE-SLOPE . . . INT+
SWEEP TIME . . 1 μSECONDS/CM

e. Adjust Oscillator amplitude for 0.5 cm deflection.

f. Vary Oscillator frequency from 500 kc to 50 cps, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range.

g. Set LEVEL to +.

h. Vary Oscillator frequency from 10 cps to 500 kc, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range. Note: some adjustment of LEVEL may be necessary at the high frequency end of the range.

i. Apply a 500 kc signal from the Oscillator to the vertical input and the external trigger input.

j. Set: LEVEL . . . . . AUTO
External trigger input . . . . . DC
TRIGGER SOURCE-SLOPE . . . EXT+
Vertical SENSITIVITY . . 1 VOLTS/CM
Vertical VERNIER . . . . . CAL
SWEEP TIME . . . . 1 μSECONDS/CM

k. Vary Oscillator frequency from 500 kc to 50 cps, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range.

m. Set TRIGGER LEVEL to +.

n. Vary Oscillator frequency from 5 cps to 500 kc, keeping deflection constant at 0.5 cm. Stable triggering should occur over the entire range.

p. Set external trigger input to AC

q. Vary Oscillator frequency from 500 kc to 20 cps, keeping amplitude constant a 0.5 p-p. Stable triggering should occur over the entire range.

r. Disconnect the Oscillator.

s. Set: TRIGGER SOURCE-SLOPE LINE+
LEVEL AUTO

t. Observe a power-line frequency waveform. The display should be synchronized.

5-18. TRIGGER POINT AND SLOPE.

a. Apply a 100 cps signal from the Oscillator to both the vertical input and the external trigger input.

b. Set: Vertical SENSITIVITY . . 2 VOLTS/CM
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . AUTO
SWEEP TIME . . 2 MILLISECONDS/CM

c. Adjust Oscillator amplitude for 10 cm deflection.

d. The sweep should trigger on the positive-going part of the waveform.

e. Check INT-, EXT+, and EXT- positions. The sweep should trigger on the proper slope for each position.

f. Vary LEVEL throughout its range. The starting point of the sweep should vary along all points on the 10 cm waveform.

5-19. SWEEP CALIBRATION.

a. Set: Vertical SENSITIVITY . . 2 VOLTS/CM
Horizontal SENSITIVITY . . . . . INTERNAL SWEEP X1
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . +
SWEEP TIME . . . . 1 μSECONDS/CM
SWEEP VERNIER . . . . . CAL

b. Apply the output of the Time Mark Generator to the vertical input. Set the output of the Time Mark Generator to 1 microsecond.

c. Adjust horizontal POSITION so that the first marker coincides with the left graticule edge.

d. The 11th marker (or the 21st marker) should occur within 0.3 cm of the right graticule edge.

e. Check all the remaining SWEEP TIME ranges, using the values shown in Table 5-3.

f. Disconnect the Time Mark Generator.

5-20. SWEEP VERNIER.

a. Set: SWEEP TIME . . . . 5 SECONDS/CM
SWEEP VERNIER . . . . . Fully counterclockwise
LEVEL . . . . . FREE RUN

b. Measure the time for the spot to travel 1 cm. The time should be 12.5 seconds or greater.

5-21. SWEEP MAGNIFIER.

a. Set: SWEEP TIME . . 1 MILLISECONDS/CM
SWEEP VERNIER . . . . . CAL
Horizontal SENSITIVITY . . . . . INTERNAL SWEEP X2
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . +

b. Apply a signal from the Time Mark Generator to the vertical input. Set the output of the Time Mark Generator to 1 millisecond.

c. Adjust horizontal POSITION so that the first marker coincides with the left graticule edge. The fifth marker should occur within 0.5 cm of the right hand graticule edge.

d. Check the remaining magnifier ranges, using the values shown in Table 5-4. The fifth, eleventh, of the 21st marker should occur within 0.5 cm of the right hand graticule edge.

5-22. INTENSITY MODULATION.

a. Set: Vertical SENSITIVITY . 10 VOLTS/CM
Vertical VERNIER . . . . . CAL
Horizontal SENSITIVITY . . . . . INTERNAL SWEEP X1
SWEEP TIME . . . 10 μSECONDS/CM

Table 5-3. Sweep Calibration

Time Mark Generator	SWEEP TIME Setting	Time Mark /10 cm
1 μsec	1 μSECONDS/CM	10
1 μsec	2 μSECONDS/CM	20
5 μsec	5 μSECONDS/CM	10
10 μsec	10 μSECONDS/CM	10
10 μsec	20 μSECONDS/CM	20
50 μsec	50 μSECONDS/CM	10
100 μsec	.1 MILLISECONDS/CM	10
100 μsec	.2 MILLISECONDS/CM	20
500 μsec	.5 MILLISECONDS/CM	10
1 msec	1 MILLISECONDS/CM	10
1 msec	2 MILLISECONDS/CM	20
5 msec	5 MILLISECONDS/CM	10
10 msec	10 MILLISECONDS/CM	10
10 msec	20 MILLISECONDS/CM	20
50 msec	20 MILLISECONDS/CM	10
100 msec	.1 SECONDS/CM	10
100 msec	.2 SECONDS/CM	20
500 msec	.5 SECONDS/CM	10
1 sec	1 SECONDS/CM	20
1 sec	2 SECONDS/CM	20
5 sec	5 SECONDS/CM	10

Table 5-4. Sweep Magnifier Calibration

(Sweep Time at 1 msec/cm)		
Time Mark Generator Output	Magnifier	Time Marks/ 10 cm
1 msec	X2	5
100 μsec	X5	20
100 μsec	X10	10
100 μsec	X20	5
10	X50	20

b. Apply a 100 kc signal from the Oscillator to the vertical input. Adjust Oscillator amplitude for 2 cm deflection.

c. Remove grounding link from Z AXIS INPUT (rear panel) and connect signal from Oscillator to Z AXIS INPUT.

d. At normal intensity, the top of the sine wave should be extinguished.

5-23, SINGLE SWEEP.

a. Set: SWEEP TIME · · 10 MILLISECONDS/CM
NORMAL-SINGLE · · · · · NORMAL
LEVEL · · · · · · · · · · · · -

b. Switch from NORMAL to SINGLE. The ARMED light should come on.

c. Set LEVEL to AUTO. A single sweep should occur, and the ARMED light should go out.

5-24. TROUBLESHOOTING.

5-25. The following paragraphs outline procedures for locating and eliminating malfunctions. Be sure that the trouble cannot be eliminated by making an adjustment, but do not make arbitrary adjustment settings; always follow the procedures given in Paragraph 5-58. To locate assemblies and other circuit components refer to Figure 5-1 and 5-2; also refer to Paragraph 5-87. Schematic diagrams for all circuits are shown in Figures 5-7, 5-11, 5-13, 5-16, 5-18, and 5-20.

5-26. ISOLATING TROUBLES TO A MAJOR SECTION.

5-27. The following checks should be performed whenever a malfunction is suspected.

5-28. POWER SUPPLIES.

a. Set: Vertical and Horizontal SENSITIVITY · ·
· · · · · · · · · · · · · 20 VOLTS/CM
Vertical and Horizontal VERNIER · CAL

b. Depress BEAM FINDER. A defocused spot should appear on the screen if the power supplies are operating properly.

5-29. AMPLIFIERS.

a. Set: Vertical and Horizontal SENSITIVITY · ·
· · · · · · · · · · · · · · · CAL
Vertical and Horizontal AMPLIFIER · AC

b. A trace tilted at 45° and having 5 cm vertical and horizontal deflection should appear if the amplifiers are operating properly.

5-30. SWEEP GENERATOR.

a. Set: Horizontal SENSITIVITY · · · · · · ·
· · · · · · · · INTERNAL SWEEP X1
LEVEL · · · · · · · · · · · · AUTO
TRIGGER SOURCE-SLOPE · · · INT+
SWEEP TIME · 1 MILLISECONDS/CM
VERNIER · · · · · · · · · · CAL
Vertical SENSITIVITY · · · · · CAL

b. A synchronized square wave, 5 cm in amplitude, should be observed if the sweep generator is operating properly.

Note

If the horizontal amplifier is not operating properly, the sweep operation will also be affected.

5-31. LOW VOLTAGE POWER SUPPLY TROUBLESHOOTING.

5-32. The two common troubles in the low voltage supplies are loss of regulation and excessive ripple. The following paragraphs outline procedures for isolating faulty components.

5-33. EXCESSIVE RIPPLE.

5-34. Excessive ripple in any of the supplies may usually be traced to two sources: defective filter capacitors or defective transistors. The ripple at the output of each supply and at the input to each regulator is given in Table 5-5. If the ripple at the output of any of the supplies is excessive, check the -100 volt supply first. If its output is normal, then check the ripple at the regulator input of the supply in question. If the ripple of the unregulated supply is excessive, check the filter capacitors and the rectifier diodes. If the ripple of the unregulated supply is normal, check for defective transistors in the amplifier series and regulator stages.

5-35. LOSS OF REGULATION.

5-36. The failure of any of the supplies is usually due to transistor failure. Table 5-6 provides a systematic procedure for troubleshooting each of the

Table 5-5. Ripple Measurements

Supply	Unregulated Ripple	Output Ripple
-100	7 v p-p	4 mv p-p
+ 12.5	4 v p-p	15 mv p-p
+ 100	10 v p-p	4 mv p-p
+ 250	5 v p-p	7 mv p-p

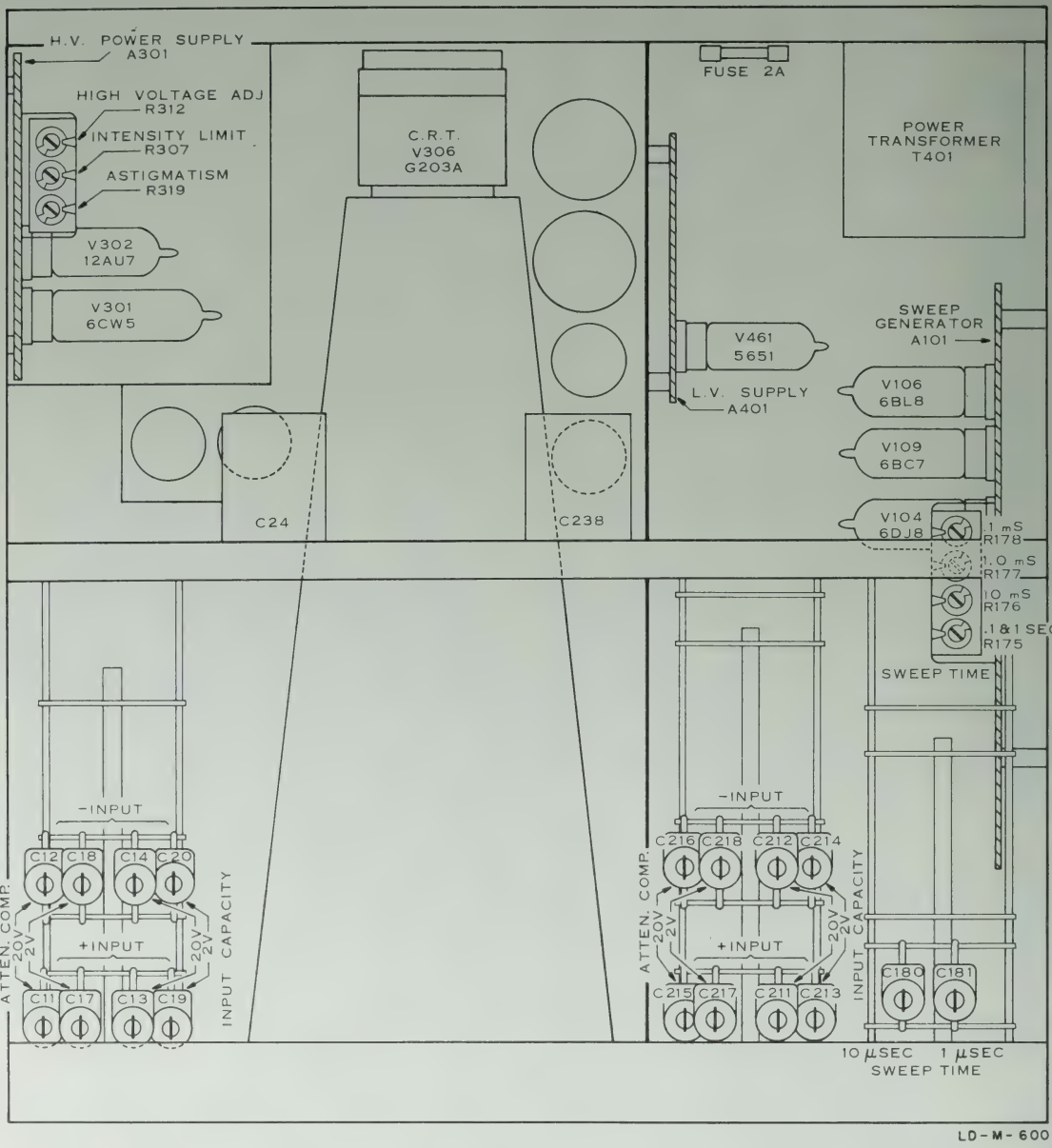


Figure 5-1. Model 130C Top View (Cover Removed)

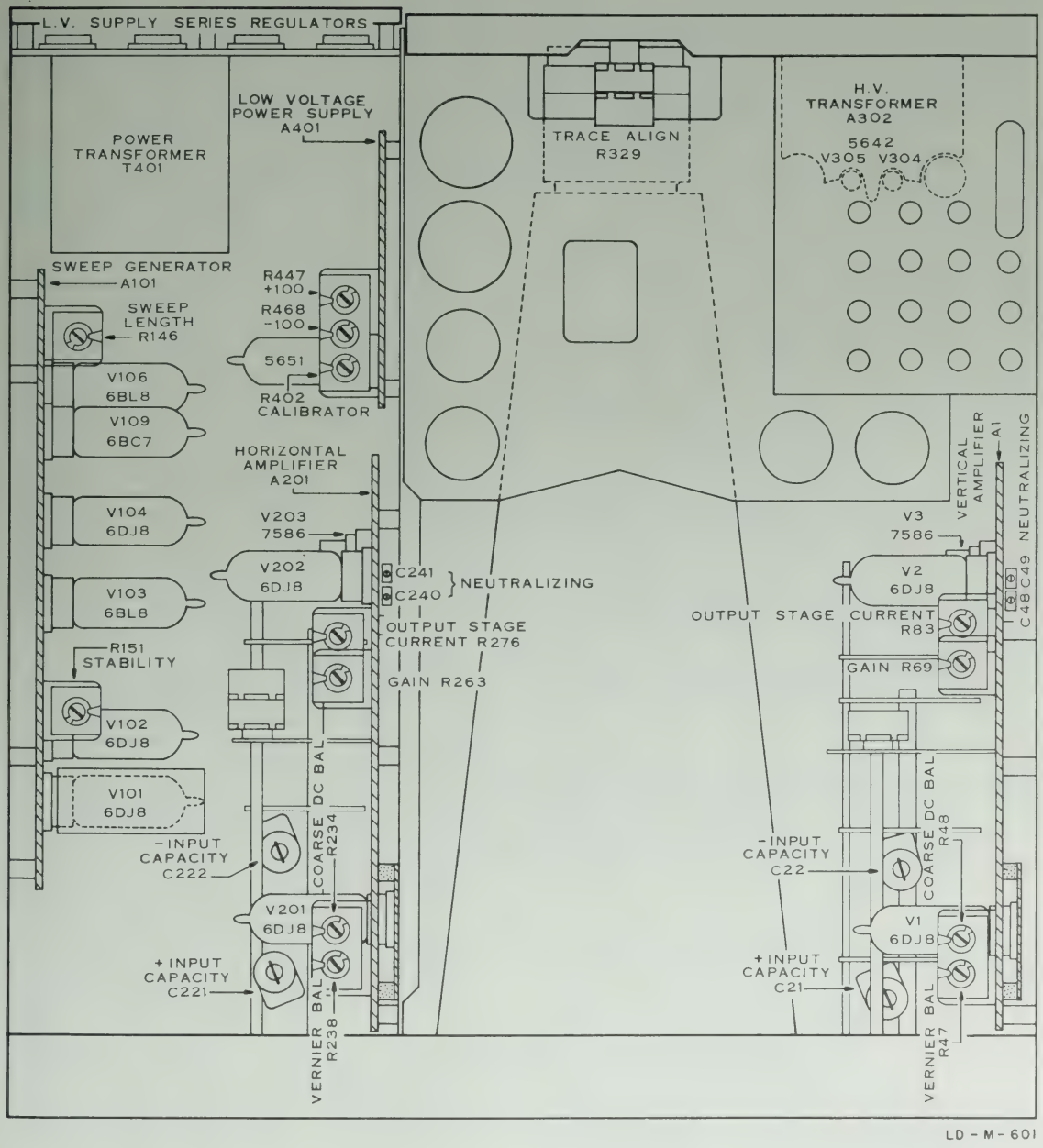


Figure 5-2. Model 130C Bottom View (Cover Removed)

Table 5-6. Low Voltage Supply Troubleshooting

Supply	Symptom	Procedure	Result	Conclusion
-100V	High Output	Disconnect base lead of Q461 (WHT/GRN/VIO lead connecting to edge of board near top of instrument).	Output remains high	Q461 shorted
			Output drops	Q461 good
		Reconnect base lead. Short emitter to collector of Q464	Output remains high	Q462 shorted
			Output drops	Q464 open or Q463
		Measure voltage across R465	Same as output	Q463 shorted
			Less than output	Q464 open
	Low Output	Measure voltage across CR462	0 volts	CR462 shorted
			0 volts	CR462 good
		Short collector to emitter of Q462	Output remains low	Q461 open
			Output rises	Q461 good
		Short collector to emitter of Q463	Output remains low	Q462 open
			Output rises	Q463 open or Q464 shorted
+ 100V	High or Low Output	Short emitter to base of Q464	Output remains low	Q464 shorted
			Output rises	Q463 open
		Check output of -100 supply	Abnormal	-100 supply
			Normal	+ 100 supply
	High Output	Disconnect base lead of Q441 (WHT/RED/GRN lead connecting to edge of board near rear of instrument).	Output remains high	Q441 shorted
			Output drops	Q441 good
		Short emitter to collector of Q443	Output remains high	Q442 open
			Output drops	Q443 open
	Low Output	Short emitter to base of Q442	Output rises	Q443 shorted
			Output remains low	Q442 shorted or Q441 open
		Measure voltage between emitter and collector of Q442	0 volts	Q442 shorted
			greater than 2 volts	Q441 open
+ 250V	High or Low Output	Check -100 and + 100 supplies	Normal	+ 250 supply
			Abnormal	-100 or + 100 supplies
	High Output	Disconnect base lead of Q421 (GRN lead connecting to edge of board near back of instrument	Output remains high	Q421 shorted
			Output drops	Q421 good
		Short emitter to base of Q422	Output remains high	Q422 shorted
			Output drops	Q423 shorted

Table 5-6. Low Voltage Supply Troubleshooting (Cont'd)

Supply	Symptom	Procedure	Result	Conclusion
	Low Output	Measure voltage across CR422	0 Volts	CR422 shorted
			+ 6 volts	CR422 good
		Short emitter to collector of Q422	Output remains low	Q421 open
			Output rises	Q422 or Q423 open
		Short emitter to collector of Q423	Output rises	Q423 open
			Output remains low	Q422 open

low voltage power supplies. The transistors associated with the low voltage supplies are located on the low voltage power supply circuit board and at the rear of the instrument. For the location of the circuit board, refer to Figure 5-1.

5-37. Resistors R421, R441, R461, and R481 protect the series regulator transistors in each of the supplies. If the output of one of the supplies is accidentally shorted, the resistor in series with the series regulator will dissipate excessive power and fail. Check each of the series resistors (located near the filter capacitors; note silkscreen identifiers) when a malfunction of the low voltage supplies is suspected.

5-38. HIGH VOLTAGE POWER SUPPLY TROUBLESHOOTING.

5-39. Waveforms and DC voltages which will aid in troubleshooting are shown on the schematic diagram.

5-40. Troubles in the high voltage power supply can best be isolated by DC voltage measurements. Any decrease in the regulated high voltage is amplified and inverted by V320 and applied to V301. The screen voltage of V301 controls the amplitude of the oscillator output, and thus the high voltage.

5-41. AMPLIFIER TROUBLESHOOTING.

5-42. Since the vertical and horizontal amplifiers are nearly identical, a single troubleshooting procedure may be used for both amplifiers.

5-43. UNBALANCE.

5-44. If the trace cannot be brought on screen with the DC BALANCE control, try adjusting R48 in the vertical amplifier or R234 in the horizontal amplifier. If the trace is still off-screen, use the following procedure to localize the unbalance.

a. Set POSITION to midrange.

b. Short grids of output tubes together (V2 in vertical, V202 in horizontal).

c. If trace remains off-screen, trouble is in output stage. If trace returns, proceed to step d.

d. Turn the instrument off.

e. Switch AMPLIFIER to DC.

f. Connect ground lead of ohmmeter to chassis.

g. Compare resistance readings at corresponding points in both halves of the amplifier. Unsymmetrical readings will indicate a source of unbalance.

h. If resistance readings do not point out the source of the unbalance, proceed to step i.

i. Turn instrument on, switch AMPLIFIER to AC and set SENSITIVITY to BAL position.

j. Measure DC voltages at corresponding points in both halves of the amplifier.

k. Switch AMPLIFIER to DC.

m. Repeat voltage measurements made in step j. Compare readings made in steps j and m with voltages shown on schematics. Any significant deviation should indicate location of the trouble.

5-45. GAIN.

5-46. If the gain of the amplifier cannot be set properly with Gain adjustment (R69 in vert, R263 in horiz.), try the next higher sensitivity range. If the gain cannot be set on this range, change V2 in vertical amplifier or V202 in horizontal amplifier, and check the high voltage output (ref. Paragraph 5-67).

5-47. LOW-FREQUENCY NOISE.

5-48. If low-frequency noise is visible on the trace, try changing the input tube (V1 in vert, V201 in horiz.). If this does not cure the trouble, change the second stage transistors (Q1, 2 in vert. Q201, 202 in horiz.).

5-49. COMPRESSION.

5-50. If the signal waveform is compressed in amplitude when the trace is moved to the top or bottom of the screen, check that the output stage current is adjusted properly (ref. Paragraph 5-74), then try changing the output tube.

5-51. SWEEP GENERATOR TROUBLESHOOTING.

5-52. If the horizontal amplifier is not operating properly, the sweep operation (not sweep circuit) will also be affected. If a sweep malfunction is observed, first check the horizontal amplifier. If the horizontal

amplifier is operating properly check typical waveforms shown in Figure 5-8 (located near schematic) proceed to the steps below.

a. Set LEVEL to FREE RUN. If the sweep operates, check V101, V102, and CR111. If the sweep does not operate, proceed to step b.

b. Check DC voltage in each of the states shown in Table 5-7. A 10 to 15% deviation from the values shown in the table can be expected; larger deviations indicate a source of trouble.

5-53. REPAIR AND REPLACEMENT.

5-54. Circuit boards used in the Model 130C have components on one side of the board and a plated conductive metal layer through component holes. When removing or replacing etched circuit components the important steps and considerations are (℗ Service Note M-20D also contains useful information on etched circuit repair):

a. Use a low heat (37 to 47.5 watts, less than 800° F idling temperature), slightly bend chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter, high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damage to the component (especially true for diodes). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

Table 5-7. Sweep Generator Troubleshooting

Test Point	Sweep Completed*	Reset**
V103 Pin 2	-100 volts	0 volts
Pin 6	92 volts	48 volts
Pin 7	-44 volts	-1 volts
V104 Pin 7	-45 volts	-57 volts
Pin 6	-4.9 volts	-2.4 volts
V106 Pin 2	4.7 volts	-.15 volts
Pin 6	195 volts	2.3 volts
Pin 8	195 volts	16 volts
Pin 9	195 volts	2.3 volts
V109 Pin 8	-9.5 volts	-74 volts
Pin 9	-9.6 volts	-74 volts

*Sweep Completed: Connect Pin 2 of V103 to ground.
**Reset: Connect Pin 2 of V103 to -100 volts (VI0 wire).

d. Large components such as potentiometers and tube sockets may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor part of the etched circuit board is a metal plated surface, covered with solder, use care to avoid overheating and lifting the conductor from the board. A conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method for repair is to solder a section of good conducting wire along the damaged area.

f. Clear the solder from the circuit board hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads in the holes and apply heat and solder, preferably on the conductor side.

5-55. Most of the wire leads to the etched circuit boards have edge-on connectors. When removing or replacing these connectors, be sure they are properly aligned with the guide slot in the board edge. Applying force with the connector mis-aligned will spring the contacts and result in a faulty electrical connection.

5-56. CATHODE RAY TUBE REPLACEMENT.

5-57. To replace the cathode ray tube, use the following procedure:

WARNING

Serious injury may result if the cathode ray tube is dropped. Handle the tube carefully.

a. Remove the bezel.

b. Loosen the clamp at the CRT socket.

c. Remove the tube socket from the clamp. It may be necessary to carefully loosen socket from clamp with a narrow-blade screwdriver.

d. Slide the tube out of the instrument.

e. Install the new CRT, reversing previous steps. Note: over-tightening the clamp at the CRT socket may damage the tube.

f. Check alignment of trace with graticule. If trace is misaligned, bring into alignment with R329, TRACE ALIGN (rear panel).

g. Check Astigmatism (ref. Paragraph 5-68).

h. Check Intensity Limit (ref. Paragraph 5-69).

i. Check Vertical Gain (ref. Paragraph 5-75).

j. Check Horizontal Gain (ref. Paragraph 5-75).

5-58. ADJUSTMENTS.

5-59. The adjustment procedures are divided into three groups. Group I adjustments include procedures of Paragraphs 5-64 through 5-69; these procedures set the power supply outputs and optimize front panel

controls for CRT display. Group II adjustments are in the procedures of Paragraphs 5-70 through 5-80; these procedures are for adjustments which are made the same way in both vertical and horizontal circuits. Group III adjustments are in the procedures of Paragraphs 5-81 through 5-86; these procedures adjust the calibrator output and the sweep generator circuit, and depend on an accurate calibration of the vertical and horizontal circuits. Refer to Figures 5-1 and 5-2 to locate adjustable components. Always make the preliminary settings of Paragraph 5-62 before following any adjustment paragraph procedure.

5-60. REQUIRED TEST EQUIPMENT.

5-61. Refer to Table 5-1 for information on instruments required for the adjustment procedures. Substitute instruments should have the characteristics described in the table.

5-62. PRELIMINARY SETTINGS.

5-63. The following settings must be made prior to following any adjustment paragraph procedure. If a setting is different from these preliminary settings, the procedure for the adjustment will specify so.

LEVEL	AUTO
TRIGGER SOURCE-SLOPE	INT+
ALL VERNIERS	CAL
ALL AC-DC	AC
Grounding links	connected
NORMAL-SINGLE	NORMAL

5-64. GROUP I ADJUSTMENTS.

5-65. LOW VOLTAGE POWER SUPPLY.

5-66. Use a DC Voltmeter to measure the output, with respect to chassis ground, of the low voltage power supplies and make adjustment or check tolerance as shown in Table 5-8. The voltage measurement can be made at any wire coded with the colors specified in Table 5-8.

5-67. HIGH VOLTAGE POWER SUPPLY.

a. Connect the Model 11044A 100:1 Voltage Divider to the DC probe of the Model 410B Voltmeter.

b. Set Voltmeter to 3-volt-DC range, and polarity to -.

c. Set the Voltmeter Calibrator for -300 volts DC output, and connect divider tip to the output.

d. Set the gain adjustment of the Model 410B (located at the rear of the instrument) for a reading of exactly 3 volts.

Table 5-8. Low Voltage Power Supply Adjustment

Supply	Tolerance	Wire Color	Adjustment
-100V		Violet	R468
+100V		White/Red	R477
+250V	+250± 7V	Red	none
+12.5V	+12.5± 1V	White/Black/Red	none

e. Set the Voltmeter to the 30-volt range, and measure the high voltage supply output at pin 8 of transformer T401.

f. If necessary, set R312, High Voltage Adj., for a Voltmeter reading of -28.5 ±1.0 volts; this corresponds to -2850 volts at the high voltage output.

g. Recalibrate the Voltmeter.

5-68. ASTIGMATISM.

a. Set both horizontal and vertical SENSITIVITY to 20 VOLTS/CM.

b. With POSITION controls, center a low intensity spot on the CRT.

c. Alternately adjust FOCUS control and Astigmatism adjustment R319, for the smallest, sharply focused round spot.

5-69. INTENSITY LIMIT.

a. Center a defocused spot on the CRT.

b. Set INTENSITY control to "ten o'clock" position.

c. Adjust R307, Intensity Limit, to just extinguish the spot.

5-70. GROUP II ADJUSTMENTS.

5-71. The procedures of Paragraphs 5-72 through 5-80 may be followed to calibrate either the vertical or horizontal circuits. The Preliminary settings of Paragraph 5-62 must be made first. Unless the procedure states otherwise, make only the setting or connection for the circuit being calibrated, that is, for either vertical or horizontal. The reference designator for the vertical adjustment is given first, followed by the corresponding horizontal adjustment, e.g. R47/R238.

5-72. VERNIER BALANCE.

a. Set SENSITIVITY to 20 MV/CM.

b. Center spot with POSITION control.

c. Switch VERNIER out of CAL position.

d. Adjust R47/R238 for minimum shift of spot when VERNIER is rotated.

5-73. COARSE DC BALANCE.

a. Set: DC BALANCE mid-range
SENSITIVITY BAL
VERNIER CAL

b. Center spot with POSITION control.

c. Switch AMPLIFIER coupling to DC.

d. Adjust R48/R234, Coarse Bal, to center the spot on CRT.

5-74. OUTPUT STAGE CURRENT.

a. Set: POSITION to center spot
SENSITIVITY 20 VOLTS/CM

b. With a DC Voltmeter, measure and note the deflection plate voltages (Green and White wires on amplifier board).

c. Adjust R83/R276, Output Stage Current, until the average of the voltages (measured in step b) is +145 volts.

d. This step applies only to the horizontal amplifier adjustment and should be performed only when a more accurate calibration is needed for use of the 10 USECONDS/CM, INTERNAL SWEEP X50 combination setting. When more accurate calibration is desired for this one sweep combination, make same settings as in step a and proceed as follows:

(1) Connect a shorting wire between the green and white wires (deflection plate leads) on the horizontal ampliier circuit board.

(2) Clip the probe of a HP Model 428A/B DC Milliammeter around the black lead from the horizontal POSITION control, R221B, to the amplifier board.

(3) Adjust R276 for a Milliammeter reading of 15 ma.

(4) Disconnect Milliammeter and remove shorting wire.

5-75. GAIN.

a. Connect the Voltmeter Calibrator to the amplifier input terminals (shorting bar in place).

b. Set SENSITIVITY to 0.1 VOLTS/CM.

c. Set output of Voltmeter Calibrator to 1 volt p-p.

d. Set R69/R263, Gain, for exactly 10 cm deflection on the CRT.

5-76. NEUTRALIZATION.

a. Connect the 75Ω output of the Square Wave Generator to the Model 130C amplifier input terminals (connect between left terminal and center terminal with grounding link in place).

b. For vertical neutralization adjustment, proceed to step c (1). For horizontal neutralization adjustment only, connect the Oscillator output to the Model 130C vertical input and to the external sync input of the Square Wave Generator; proceed to step c (2).

c. Make appropriate settings as follows:

(1) For vertical neutralization only, set
SWEEP TIME · · · · 5 μSECONDS/CM
Horiz. SENSITIVITY · INTERNAL SWEEP X1
Vertical SENSITIVITY · · 0.2 VOLTS/CM

(2) For horizontal neutralization only set
Vertical SENSITIVITY · · 5 VOLTS/CM
Horizontal SENSITIVITY · · 0.2 VOLTS/CM

d. Set Square Wave Generator frequency to 50 kc. For horizontal neutralization, also set Oscillator frequency to 25 kc.

e. Obtain CRT display as follows:

(1) For vertical adjustment only, set Square Wave Generator output for about 8 cm deflection.

(2) For horizontal adjustment only, set both signal source amplitudes for about 8 centimeters deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed as in Figure 5-3.

f. Alternately adjust C48/C240 and C49/C241 for best rise time with no overshoot. Figure 5-3 illustrates the waveforms for the horizontal neutralization adjustment.

Note

A step input signal with a risetime much faster than the Oscilloscope risetime, such as the HP Model 211A signal, may cause a noticeable preshoot on the trace. This does not affect the accuracy of the adjustment and does not occur for signals within the specified risetime of the Model 130C.

g. Disconnect shorting link from center input terminal and connect Square Wave Generator between center and ground (black) terminals.

h. Connect a short jumper wire from the left input terminal to the ground terminal.

i. Note the square wave response. A slight rounding on the leading edge is permissible. If desired, a compromise adjustment of C48/C240 and C49/C241 can be made with Square Wave Generator signal applied alternately to the left terminal (with center terminal grounded) and to the center terminal (with left terminal grounded).

5-77. INPUT CAPACITANCE AND ATTENUATOR FREQUENCY COMPENSATION.

5-78. There are two methods for adjusting input capacitance. One method requires a capacitance meter or bridge and the other method requires an alignment attenuator previously set (by L-C Meter or capacitance bridge) for a specific value (see item 9 in Table 5-1). Paragraphs 5-79 and 5-80 provide the procedures for these two methods.

5-79. PROCEDURE USING CAPACITANCE METER.

a. Set amplifier SENSITIVITY to 0.2 VOLTS/CM.

b. Disconnect the ground link from the center terminal of the Model 130C amplifier input.

c. Connect the L-C Meter between the left (+ input) and right (ground) terminals.

d. Adjust C21/C221, + Input Capacity, for a reading of 45 pf on the L-C Meter.

Note

For Model 130C instruments with Option 06 (see Paragraph 1-9), change all references in this procedure from "45 pf" to "85 pf". This is necessary because of input capacitance added by the cabling to the rear panel connectors.

e. Connect the L-C Meter between the center (- input) and right (ground) terminals.

f. Adjust C22/C222, -Input Capacity, for a reading of 45 pf on the L-C Meter.

g. Disconnect the L-C Meter.

h. Connect the signal lead of the Square Wave Generator 600Ω output to the left terminal (+ input) of the amplifier input. Connect a short wire from

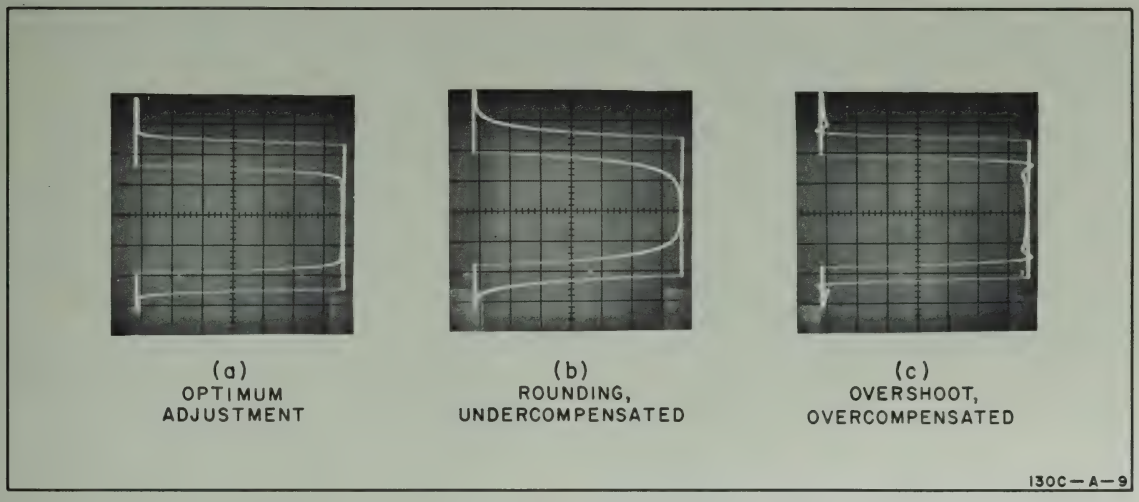


Figure 5-3. Horizontal Neutralization Adjustment Waveforms

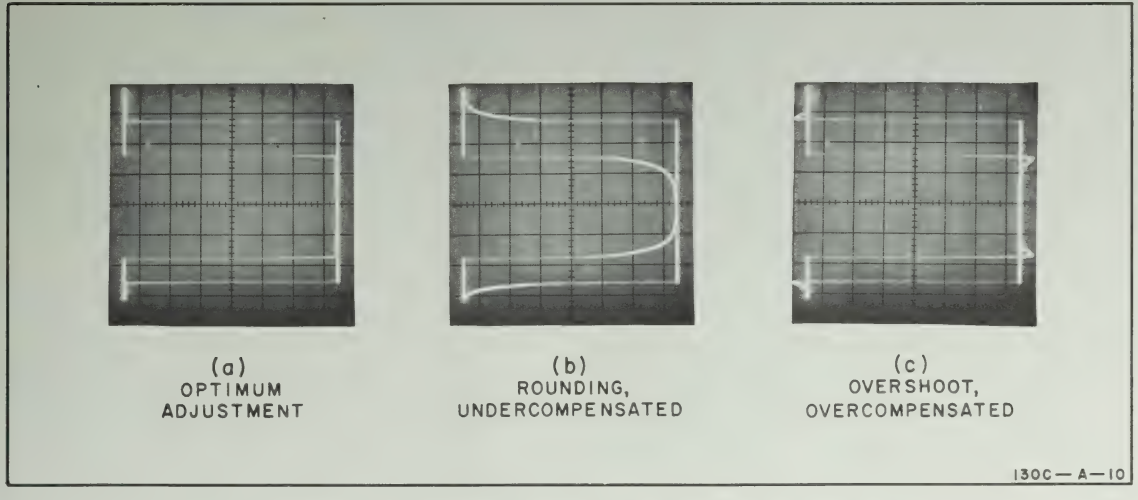


Figure 5-4. Horizontal Attenuator Compensation Waveforms

the right terminal to the ground side of the signal source. Also be sure the ground side of the signal input connector goes to the center terminal.

i. For vertical capacitance and compensation adjustment, proceed to step j (1). For horizontal adjustment only, connect the Oscillator output to the Model 130C vertical input terminals and to the external sync input of the Square Wave Generator; proceed to step j (2).

j. Make settings as follows:

(1) For vertical adjustment only,
SWEEP TIME . . . . . 20 μSECONDS/CM
Horizontal SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . . . 2 VOLTS/CM

(2) For horizontal adjustment only,
Vertical SENSITIVITY . . . . . 5 VOLTS/CM
Horizontal SENSITIVITY . . . . 2 VOLTS/CM

k. Set Square Wave Generator frequency to 10 kc. For horizontal adjustment, also set Oscillator frequency to 5 kc.

m. Obtain CRT display as follows:

(1) For vertical adjustment, set Square Wave Generator output for about 8 cm deflection.

(2) For horizontal adjustment, set both signal source amplitudes for about 8 cm deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed (see Figure 5-4).

n. Adjust C17/C217, 2V Atten. Comp, for best square wave. Figure 5-4 illustrates the waveforms for the horizontal compensation adjustment.

p. Set SENSITIVITY to 5 VOLTS/CM. Adjust Square Wave Generator amplitude for about 8 cm deflection.

q. Adjust C11/C215, 20V Atten. Comp, for best square wave. Note that this adjustment is for the 5, 10, and 20 volt ranges.

r. Change Square Wave Generator signal lead to the center terminal of the input. Connect a short lead between the left and right terminals (lead still connected from Oscilloscope ground terminal to ground side of signal source).

s. Adjust C12/C216, 20V Atten. Comp, for best square wave. Note that this adjustment is for 5, 10, and 20 volt ranges.

t. Change SENSITIVITY to 2 VOLTS/CM. Adjust Square Wave Generator output for about 8 cm deflection.

u. Adjust C18/C218, 2V Atten. Comp, for best square wave.

v. Use appropriate procedure following:

(1) If using an L-C Meter for capacity adjustments, disconnect the Square Wave Generator and jumper wires. Refer to Table 5-9 and make L-C Meter connections, SENSITIVITY settings, and adjustments as specified.

(2) If using the alternate method of Paragraph 5-80, retain the same instrument setup of step u in Paragraph 5-79. Change the Square Wave Generator frequency to 1 kc. For the vertical adjustment, change SWEEP TIME to 0.2 MILLISECONDS/CM, or for the horizontal adjustment, change Oscillator frequency to 500 cps. Refer to Table 5-9 and connect the square wave through the Alignment Attenuator to the specified terminals (unused red input terminal should always be connected to Oscilloscope ground). At each SENSITIVITY setting adjust signal amplitude for about 8 cm deflection and make the adjustment shown in the table.

Table 5-9. Input Capacity Adjustment

Amplifier Input Connections	SENSITIVITY Setting	Adjust for 45 pf or best Square Wave
left and right terminals	2 VOLTS/CM	C19/C213
left and right terminals	5 VOLTS/CM	C13/C211
center and right terminals	5 VOLTS/CM	C14/C212
center and right terminals	2 VOLTS/CM	C20/C214

5-80. ALTERNATE METHOD USING ALIGNMENT ATTENUATOR.

Note

If the Alignment Attenuator has been previously adjusted to match a 45 pf input capacity, steps b and h may be omitted.

a. Disconnect ground link from amplifier input center terminal.

b. Set SENSITIVITY to 0.2 VOLTS/CM and measure input capacity (between left and right terminals) with an L-C Meter or capacitance bridge. Adjust C21/C221 for a reading of 45 pf.

c. Connect the 600Ω output of the Square Wave Generator through the Alignment Attenuator to the left (+ input) and right (ground) terminals of the input. Ground center terminal.

d. For vertical circuit adjustment, proceed to step e (1). For horizontal circuit only connect the Oscillator output to the Model 130C vertical input terminals and to the external sync input of the Square Wave Generator; proceed to step e (2).

e. Make Model 130C setting as follows:

(1) For vertical adjustment only,
SWEEP TIME . . . 0.2 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 0.2 VOLTS/CM

(2) For horizontal adjustment only,
Vertical SENSITIVITY . . . 5 VOLTS/CM
Horizontal SENSITIVITY . . . 0.2 VOLTS/CM

f. Set Square Wave Generator frequency to 1 kc. For horizontal adjustment, also set Oscillator frequency to 500 cps.

g. Obtain CRT display as follows:

(1) For vertical adjustment, set Square Wave Generator output for about 8 cm deflection.

(2) For horizontal adjustment, set both signal source amplitudes for about 8 cm deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed.

h. Set adjustment on Alignment Attenuator for best square wave response; it is now adjusted for 45 pf inputs.

i. Adjust C21/C221, + Input Capacity, for best square wave.

j. Change square wave signal lead through Alignment Attenuator to the input center terminal. Ground left terminal.

k. Adjust C22/C222, - Input Capacity, for best square wave.

m. Disconnect Alignment Attenuator and Oscillator. Proceed to Paragraph 5-79, step h, and complete the adjustment procedure there. In step v (2), use Alignment Attenuator as explained.

5-81. GROUP III ADJUSTMENTS.

5-82. The procedures of Paragraph 5-83 through 5-86 allow proper adjustment of the Calibrator circuit

and of the sweep circuit. For the Calibrator adjustment, the vertical amplifier gain must first be set accurately. For sweep generator adjustments, the horizontal amplifier must first be accurately calibrated.

5-83. CALIBRATOR.

a. Check adjustment of the vertical amplifier gain as set in Paragraph 5-75.

b. Set Model 130C as follows:
Vertical SENSITIVITY . . . 50 MV/CM
Vertical INPUT . . . . . DC
Horiz. SENSITIVITY . INTERNAL SWEEP X1
SWEEP TIME . . . 1 MILLISECONDS/CM

c. Connect a short lead from 500 MV CALIBRATOR output to the vertical amplifier input terminal.

d. Adjust R402, Calib, for exactly 10 cm deflection.

5-84. SWEEP STABILITY.

a. Set Model 130C as follows:
LEVEL . . . . . just out of AUTO
SWEEP TIME . . 0.2 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 20 VOLTS/CM

b. Set DC Voltmeter range to -100V and check voltage at pin 2 of tube V103.

c. Rotate R151, Stability, counter clockwise until the trace just disappears. (If no trace was present initally, first rotate R151 clockwise until trace appears, then back ccw until it just disappears).

d. Note DC voltage reading (typically about -55 volts).

e. Set R151 slightly ccw for a voltage reading of 2 volts less negative than noted in step d.

5-85. SWEEP LENGTH.

a. Connect the Oscillator to the vertical input terminals.

b. Set Model 130C as follows:
LEVEL . . . . . mid-range
SWEEP TIME . . 0.1 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 1 VOLTS/CM

c. Set Oscillator frequency to 500 kc and adjust amplitude for a 6 cm display on CRT.

d. Observe end of sweep and adjust LEVEL control for shortest sweep.

e. Adjust R146, Sweep Length, for a sweep length of 10.75 cm.

5-86. SWEEP TIME CALIBRATION.

a. Check adjustment of horizontal amplifier gain as set in Paragraph 5-75.

b. Set Model 130C as follows:
LEVEL . . . . . mid-range
Horizontal SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 1 VOLTS/CM

c. Connect Time Mark Generator to the Model 130C vertical input.

d. Refer to Table 5-10 and at the setting shown, adjust component for one time mark per centimeter.

5-87. COMPONENT LOCATION.

5-88. Figures 5-1 and 5-2 indicate the location of most tubes, assemblies, and adjustments. Components on etched circuit boards are identified by silk screened reference designators. To supplement this, figures are included near the corresponding circuit schematic diagram to help locate components where silk screening is difficult to see. Switch components are identified in pictures, also located near the corresponding schematic diagram. Refer to the List of Illustrations at the front of this manual for page references to these component location figures.

Table 5-10. Sweep Time Calibration

SWEEP TIME setting	Time Mark Generator	Adjustment
1 μSECONDS/CM	1 μsec	C181
10 μSECONDS/CM	10 μsec	C180
.1 MILLISECONDS/CM	100 μsec	R178
1 MILLISECONDS/CM	1 msec	R177
10 MILLISECONDS/CM	10 msec	R176
.1 SECONDS/CM	100 msec	R175

n. Adjust C17/C217, 2V Atten. Comp, for best square wave. Figure 5-4 illustrates the waveforms for the horizontal compensation adjustment.

p. Set SENSITIVITY to 5 VOLTS/CM. Adjust Square Wave Generator amplitude for about 8 cm deflection.

q. Adjust C11/C215, 20V Atten. Comp, for best square wave. Note that this adjustment is for the 5, 10, and 20 volt ranges.

r. Change Square Wave Generator signal lead to the center terminal of the input. Connect a short lead between the left and right terminals (lead still connected from Oscilloscope ground terminal to ground side of signal source).

s. Adjust C12/C216, 20V Atten. Comp, for best square wave. Note that this adjustment is for 5, 10, and 20 volt ranges.

t. Change SENSITIVITY to 2 VOLTS/CM. Adjust Square Wave Generator output for about 8 cm deflection.

u. Adjust C18/C218, 2V Atten. Comp, for best square wave.

v. Use appropriate procedure following:

(1) If using an L-C Meter for capacity adjustments, disconnect the Square Wave Generator and jumper wires. Refer to Table 5-9 and make L-C Meter connections, SENSITIVITY settings, and adjustments as specified.

(2) If using the alternate method of Paragraph 5-80, retain the same instrument setup of step u in Paragraph 5-79. Change the Square Wave Generator frequency to 1 kc. For the vertical adjustment, change SWEEP TIME to 0.2 MILLISECONDS/CM, or for the horizontal adjustment, change Oscillator frequency to 500 cps. Refer to Table 5-9 and connect the square wave through the Alignment Attenuator to the specified terminals (unused red input terminal should always be connected to Oscilloscope ground). At each SENSITIVITY setting adjust signal amplitude for about 8 cm deflection and make the adjustment shown in the table.

Table 5-9. Input Capacity Adjustment

Amplifier Input Connections	SENSITIVITY Setting	Adjust for 45 pf or best Square Wave
left and right terminals	2 VOLTS/CM	C19/C213
left and right terminals	5 VOLTS/CM	C13/C211
center and right terminals	5 VOLTS/CM	C14/C212
center and right terminals	2 VOLTS/CM	C20/C214

5-80. ALTERNATE METHOD USING ALIGNMENT ATTENUATOR.

Note

If the Alignment Attenuator has been previously adjusted to match a 45 pf input capacity, steps b and h may be omitted.

a. Disconnect ground link from amplifier input center terminal.

b. Set SENSITIVITY to 0.2 VOLTS/CM and measure input capacity (between left and right terminals) with an L-C Meter or capacitance bridge. Adjust C21/C221 for a reading of 45 pf.

c. Connect the 600Ω output of the Square Wave Generator through the Alignment Attenuator to the left (+ input) and right (ground) terminals of the input. Ground center terminal.

d. For vertical circuit adjustment, proceed to step e (1). For horizontal circuit only connect the Oscillator output to the Model 130C vertical input terminals and to the external sync input of the Square Wave Generator; proceed to step e (2).

e. Make Model 130C setting as follows:

(1) For vertical adjustment only,
SWEEP TIME . . . 0.2 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 0.2 VOLTS/CM

(2) For horizontal adjustment only,
Vertical SENSITIVITY . . . 5 VOLTS/CM
Horizontal SENSITIVITY . . . 0.2 VOLTS/CM

f. Set Square Wave Generator frequency to 1 kc. For horizontal adjustment, also set Oscillator frequency to 500 cps.

g. Obtain CRT display as follows:

(1) For vertical adjustment, set Square Wave Generator output for about 8 cm deflection.

(2) For horizontal adjustment, set both signal source amplitudes for about 8 cm deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed.

h. Set adjustment on Alignment Attenuator for best square wave response; it is now adjusted for 45 pf inputs.

i. Adjust C21/C221, + Input Capacity, for best square wave.

j. Change square wave signal lead through Alignment Attenuator to the input center terminal. Ground left terminal.

k. Adjust C22/C222, - Input Capacity, for best square wave.

m. Disconnect Alignment Attenuator and Oscillator. Proceed to Paragraph 5-79, step h, and complete the adjustment procedure there. In step v (2), use Alignment Attenuator as explained.

5-81. GROUP III ADJUSTMENTS.

5-82. The procedures of Paragraph 5-83 through 5-86 allow proper adjustment of the Calibrator circuit

and of the sweep circuit. For the Calibrator adjustment, the vertical amplifier gain must first be set accurately. For sweep generator adjustments, the horizontal amplifier must first be accurately calibrated.

5-83. CALIBRATOR.

a. Check adjustment of the vertical amplifier gain as set in Paragraph 5-75.

b. Set Model 130C as follows:
Vertical SENSITIVITY . . . 50 MV/CM
Vertical INPUT . . . . . DC
Horiz. SENSITIVITY . INTERNAL SWEEP X1
SWEEP TIME . . . 1 MILLISECONDS/CM

c. Connect a short lead from 500 MV CALIBRATOR output to the vertical amplifier input terminal.

d. Adjust R402, Calib, for exactly 10 cm deflection.

5-84. SWEEP STABILITY.

a. Set Model 130C as follows:
LEVEL . . . . . just out of AUTO
SWEEP TIME . . 0.2 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 20 VOLTS/CM

b. Set DC Voltmeter range to -100V and check voltage at pin 2 of tube V103.

c. Rotate R151, Stability, counter clockwise until the trace just disappears. (If no trace was present initally, first rotate R151 clockwise until trace appears, then back ccw until it just disappears).

d. Note DC voltage reading (typically about -55 volts).

e. Set R151 slightly ccw for a voltage reading of 2 volts less negative than noted in step d.

5-85. SWEEP LENGTH.

a. Connect the Oscillator to the vertical input terminals.

b. Set Model 130C as follows:
LEVEL . . . . . mid-range
SWEEP TIME . . 0.1 MILLISECONDS/CM
Horiz. SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 1 VOLTS/CM

c. Set Oscillator frequency to 500 kc and adjust amplitude for a 6 cm display on CRT.

d. Observe end of sweep and adjust LEVEL control for shortest sweep.

e. Adjust R146, Sweep Length, for a sweep length of 10.75 cm.

5-86. SWEEP TIME CALIBRATION.

a. Check adjustment of horizontal amplifier gain as set in Paragraph 5-75.

b. Set Model 130C as follows:
LEVEL . . . . . mid-range
Horizontal SENSITIVITY . INTERNAL SWEEP X1
Vertical SENSITIVITY . . . 1 VOLTS/CM

c. Connect Time Mark Generator to the Model 130C vertical input.

d. Refer to Table 5-10 and at the setting shown, adjust component for one time mark per centimeter.

5-87. COMPONENT LOCATION.

5-88. Figures 5-1 and 5-2 indicate the location of most tubes, assemblies, and adjustments. Components on etched circuit boards are identified by silk screened reference designators. To supplement this, figures are included near the corresponding circuit schematic diagram to help locate components where silk screening is difficult to see. Switch components are identified in pictures, also located near the corresponding schematic diagram. Refer to the List of Illustrations at the front of this manual for page references to these component location figures.

Table 5-10. Sweep Time Calibration

SWEEP TIME setting	Time Mark Generator	Adjustment
1 μSECONDS/CM	1 μsec	C181
10 μSECONDS/CM	10 μsec	C180
.1 MILLISECONDS/CM	100 μsec	R178
1 MILLISECONDS/CM	1 msec	R177
10 MILLISECONDS/CM	10 msec	R176
.1 SECONDS/CM	100 msec	R175

SCHEMATIC DIAGRAM NOTES

1. Unless otherwise indicated: resistance is in ohms, inductance is in microhenries, and capacitance is in picofarads.
2. Titles enclosed in boxes indicate front-panel engraving.
3. Solid weighted lines indicate signal paths. Broken weighted lines indicate feedback paths.
4. Conditions for DC Voltage Measurements (Typical values shown on schematics may vary ± 10%).
   a. Vertical Amplifier and Horizontal Amplifier
      (1) Follow steps 1 through 10 of Figure 3-3.
   b. Sweep Generator
      (1) TRIGGER SOURCE-SLOPE . . . . . INT+
      (2) HORIZONTAL SENSITIVITY X1
      (3) Monitor DC voltage at pin 2 of V101 (WHT-GRN-VIO wire) and adjust LEVEL control for 0 volts reading.
5. Sweep Generator Waveforms - see Figure 5-8 and schematic, Figure 5-11.
6. * = Factory selected part, may be omitted; average value shown.
   ⏚ instrument chassis ground.

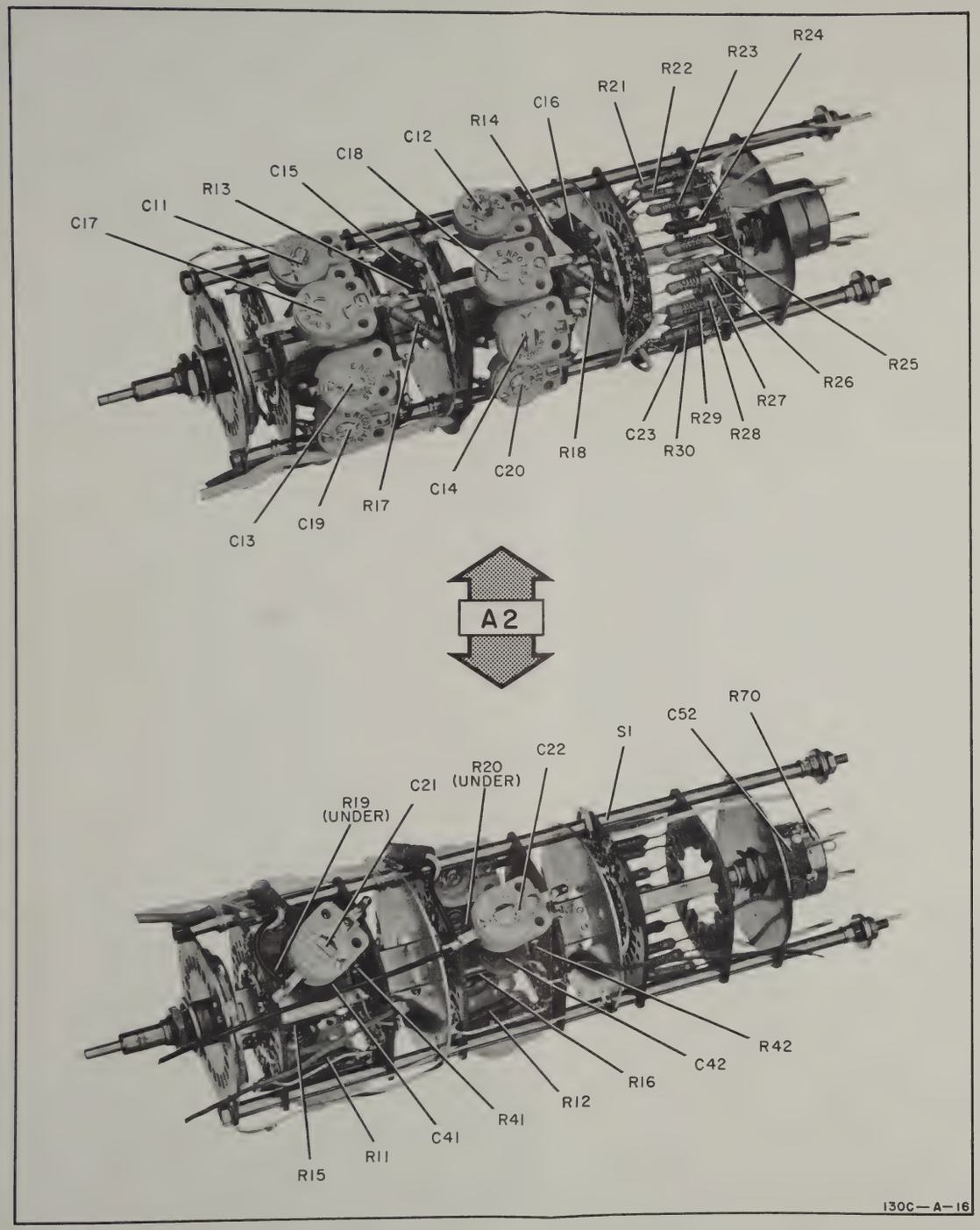


Figure 5-5. Vertical Attenuator, A2, Component Location

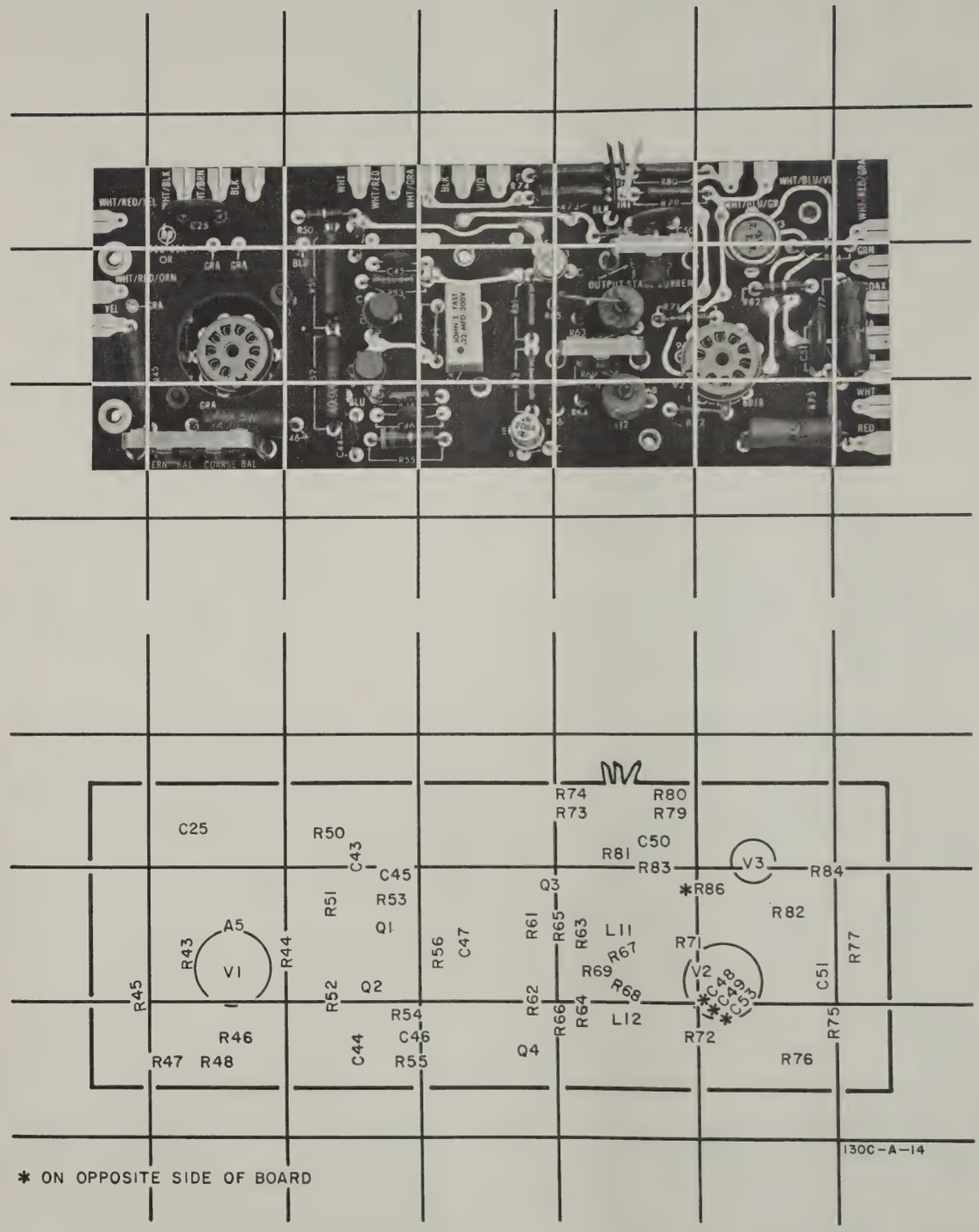


Figure 5-6. Vertical Amplifier, A1, Component Location

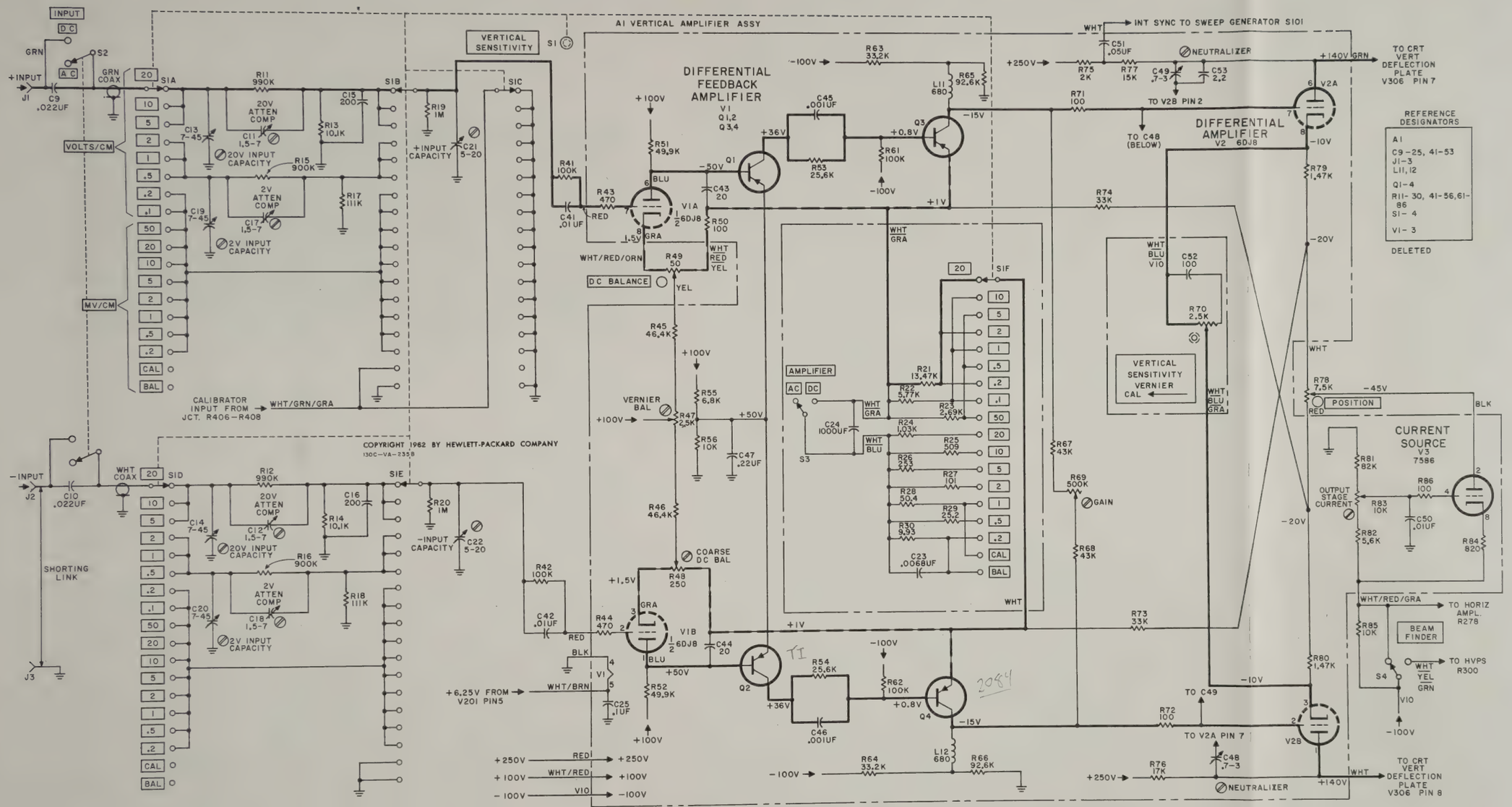
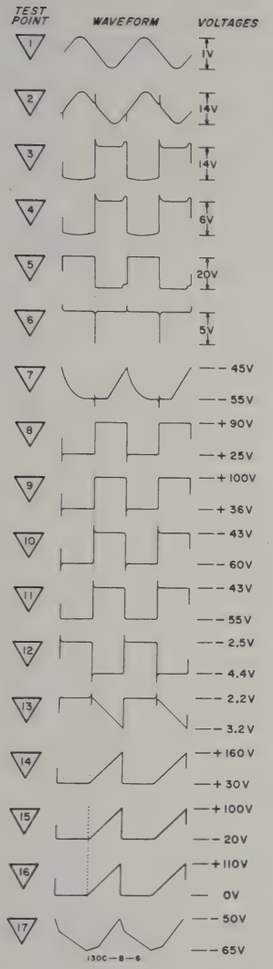


Figure 5-7. Vertical Attenuator and Amplifier Schematic



Note: Waveforms taken with a 2 kc, 1 volt peak-to-peak sine wave applied to the Trigger Input terminal (number 5 in Figure 3-2). Make the following settings on Model 130C:

TRIGGER SENSITIVITY	EXT. -
LEVEL	AUTO
SWEEP	20 μseconds/cm
SWEEP VERNIER	CAL
Horizontal POSITION	center trace

Figure 5-8. Sweep Generator Circuit Waveforms

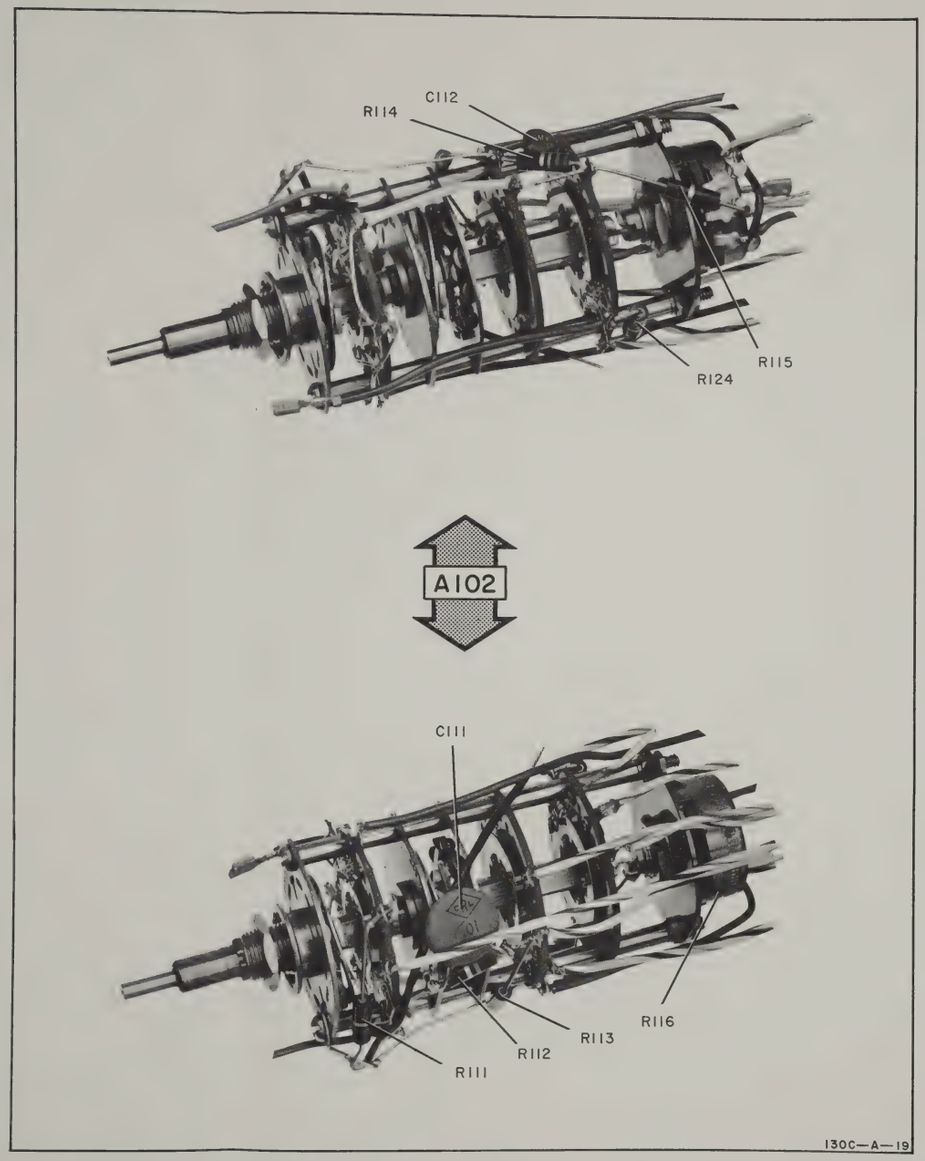


Figure 5-9. Trigger Source - Level Switch, A102, Component Location

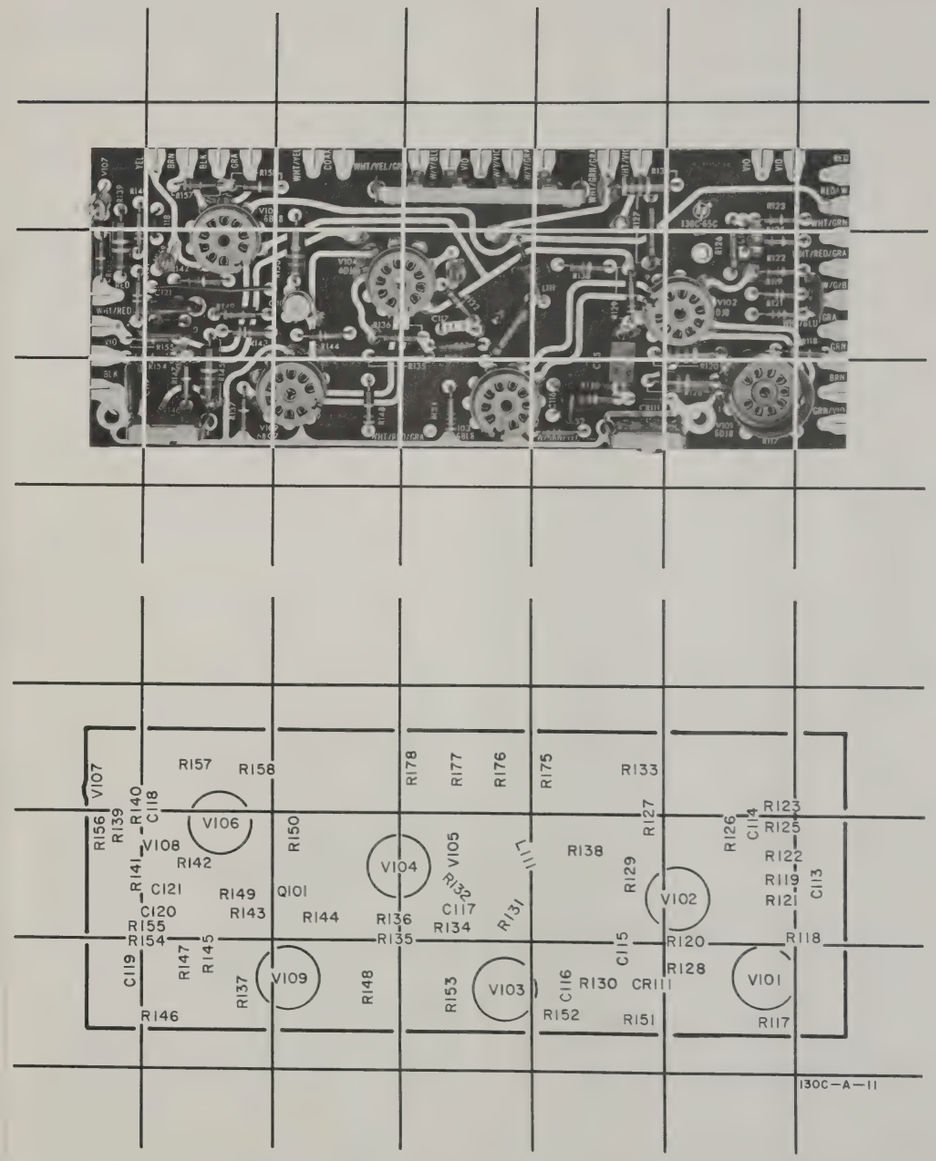


Figure 5-10. Sweep Generator, A101, Component Location

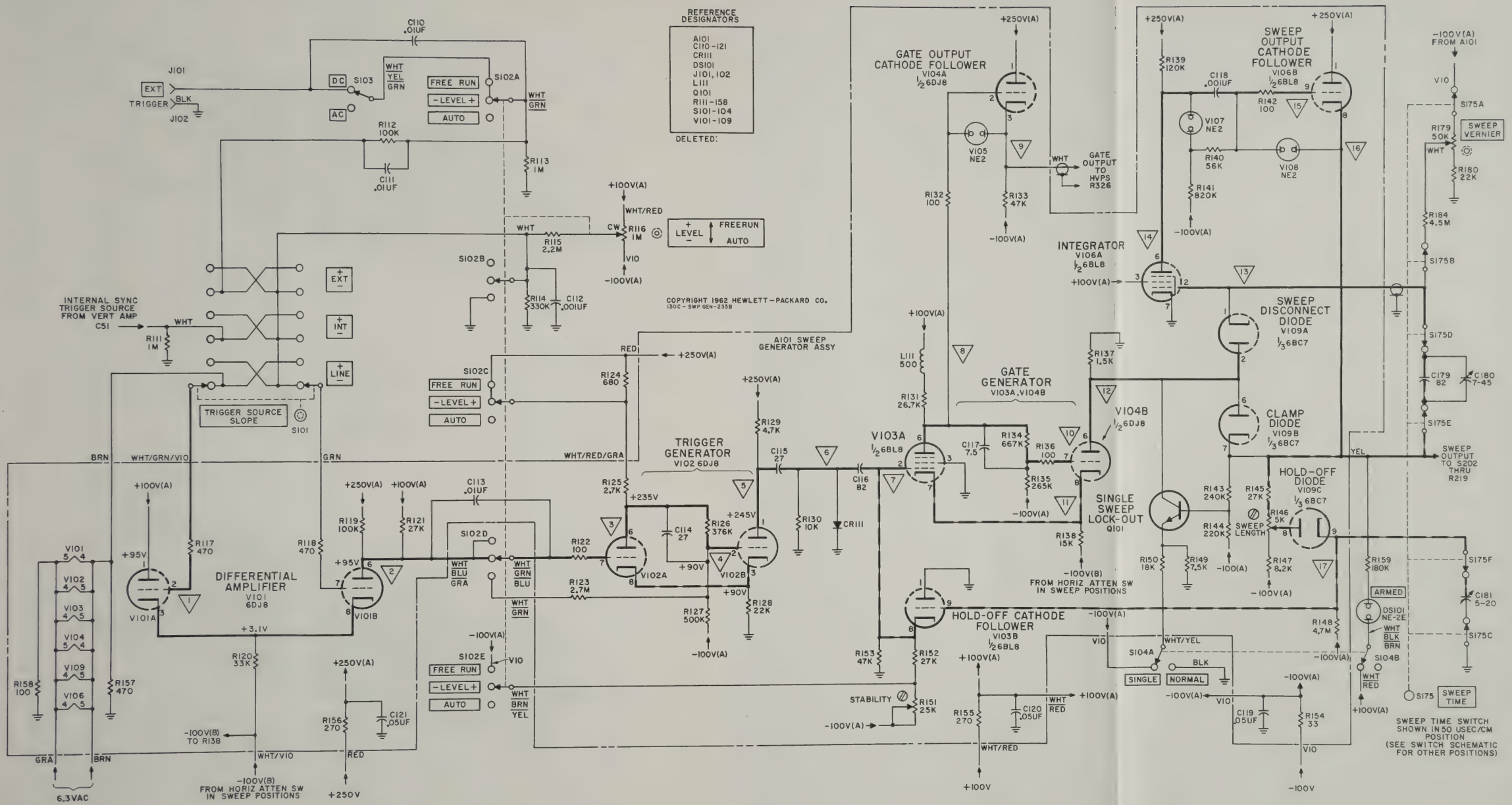


Figure 5-11. Sweep Generator Schematic

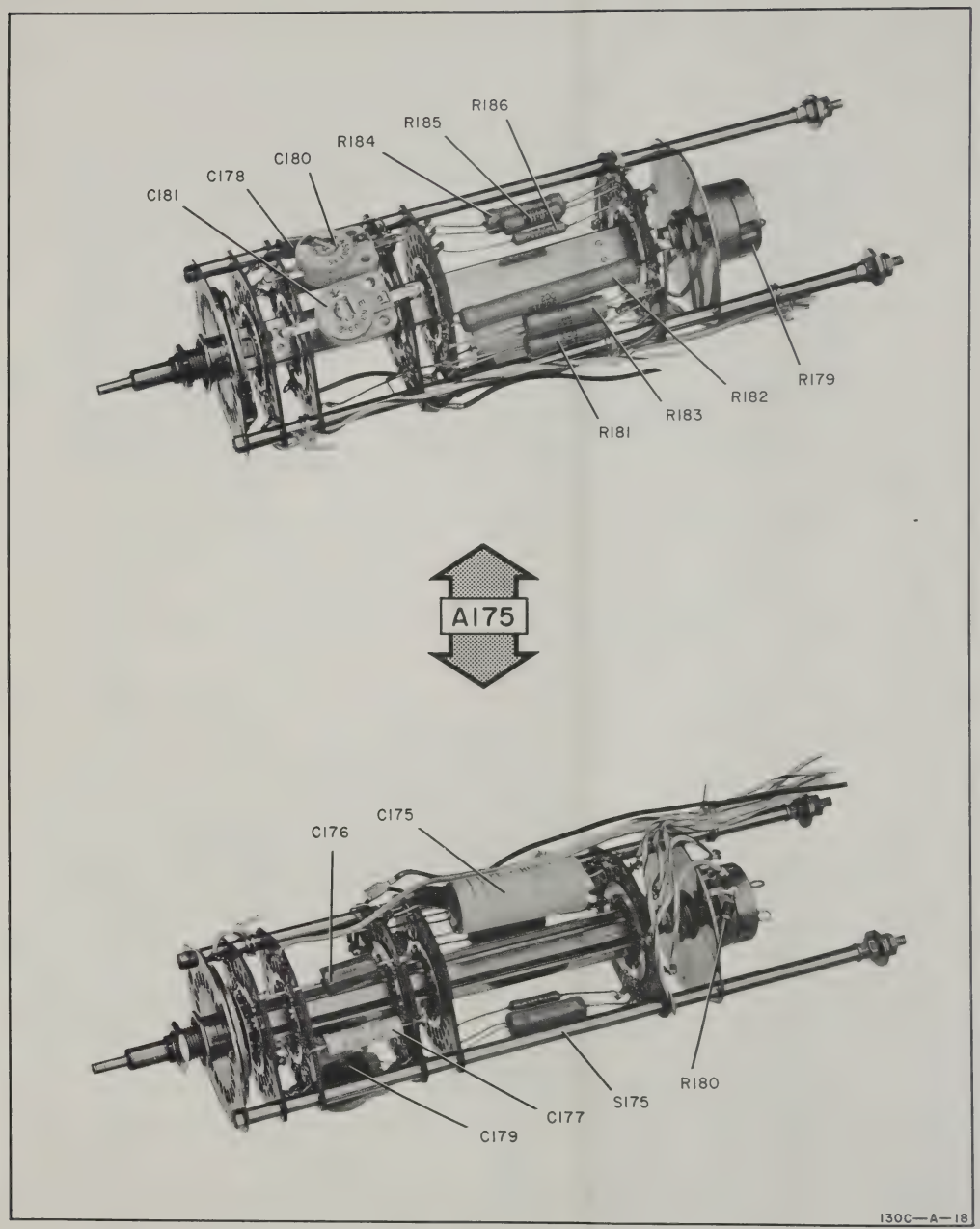


Figure 5-12. Sweep Time Switch, A175, Component Location

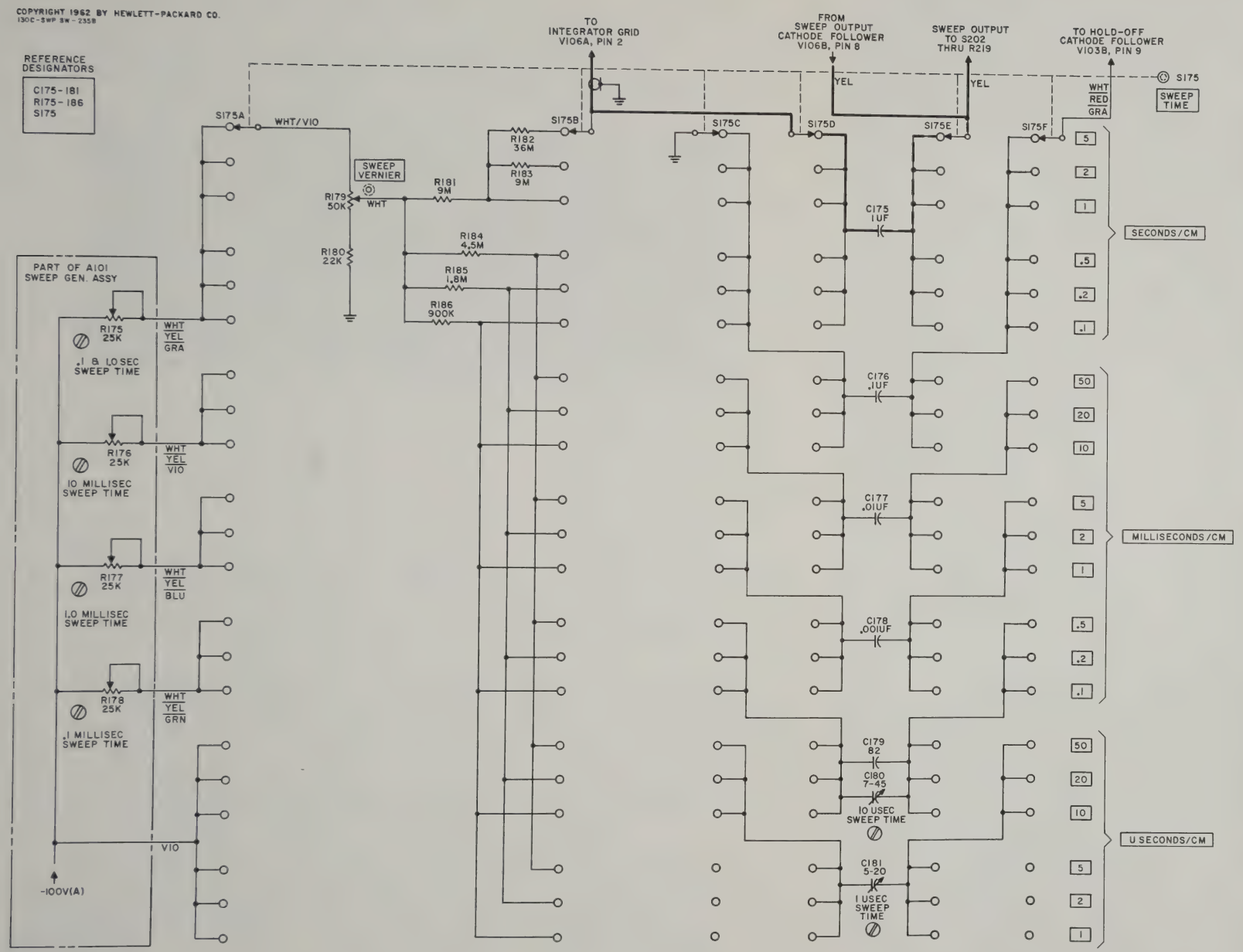


Figure 5-13. Sweep Time Schematic

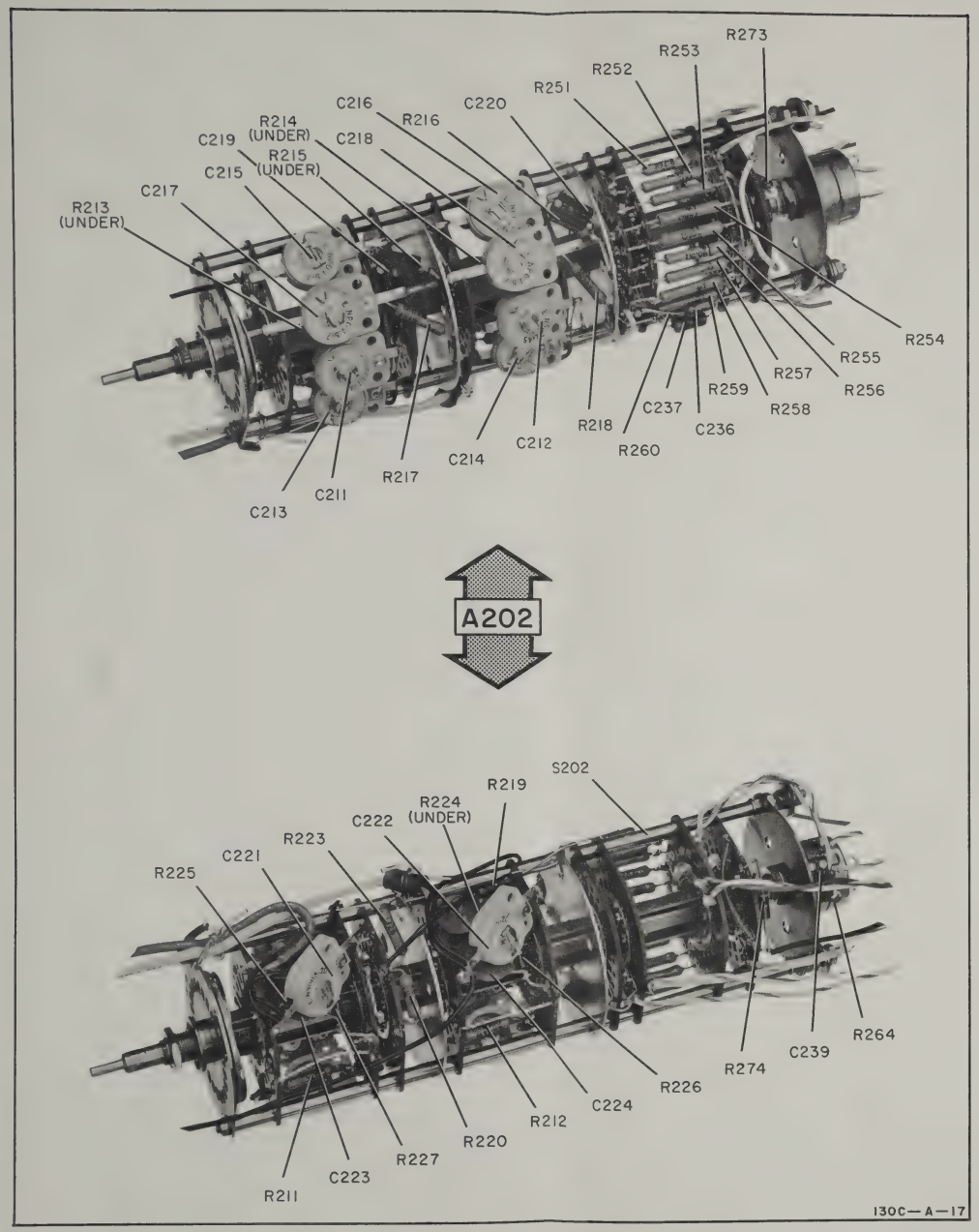


Figure 5-14. Horizontal Attenuator, A202, Component Location

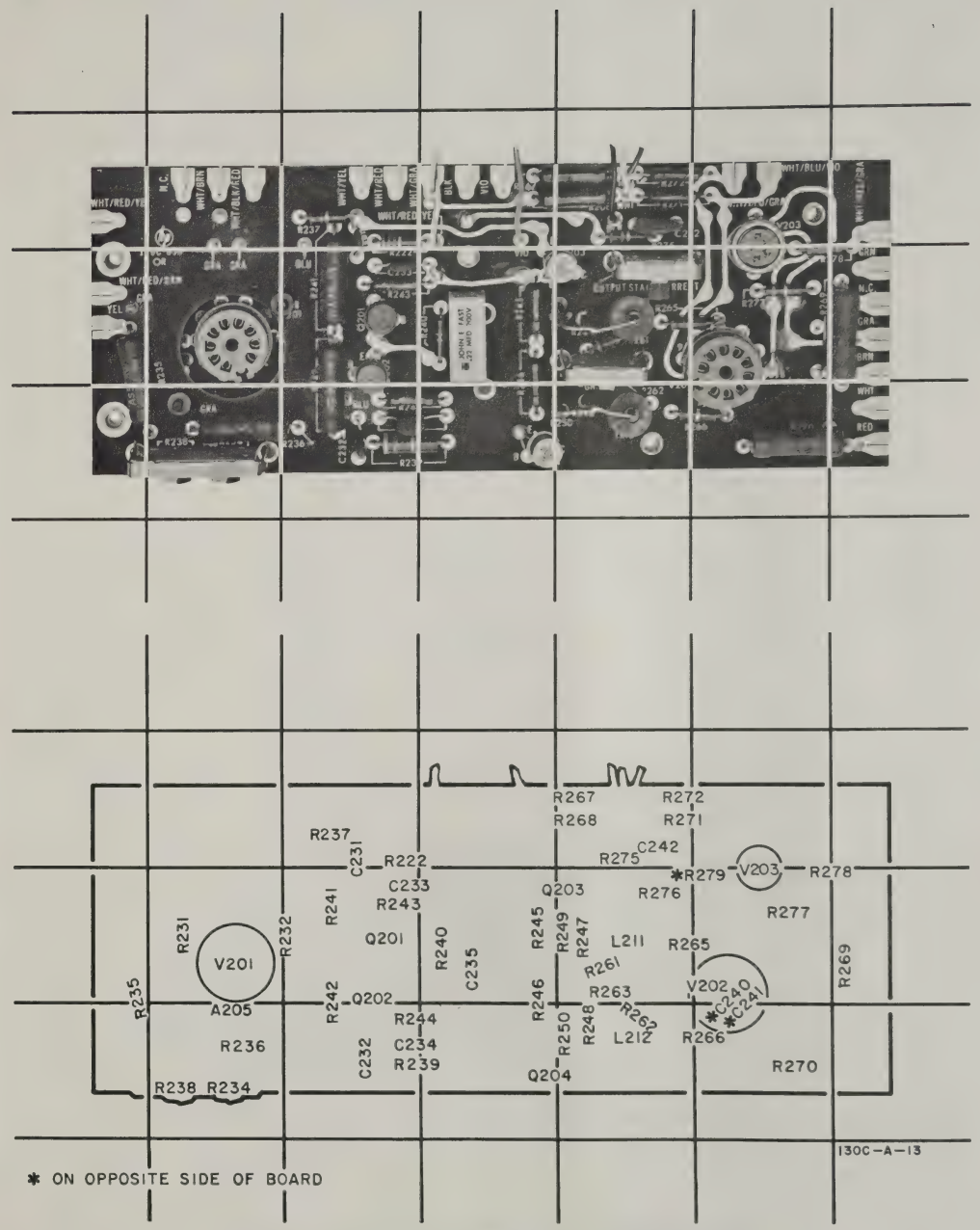


Figure 5-15. Horizontal Amplifier, A201, Component Location

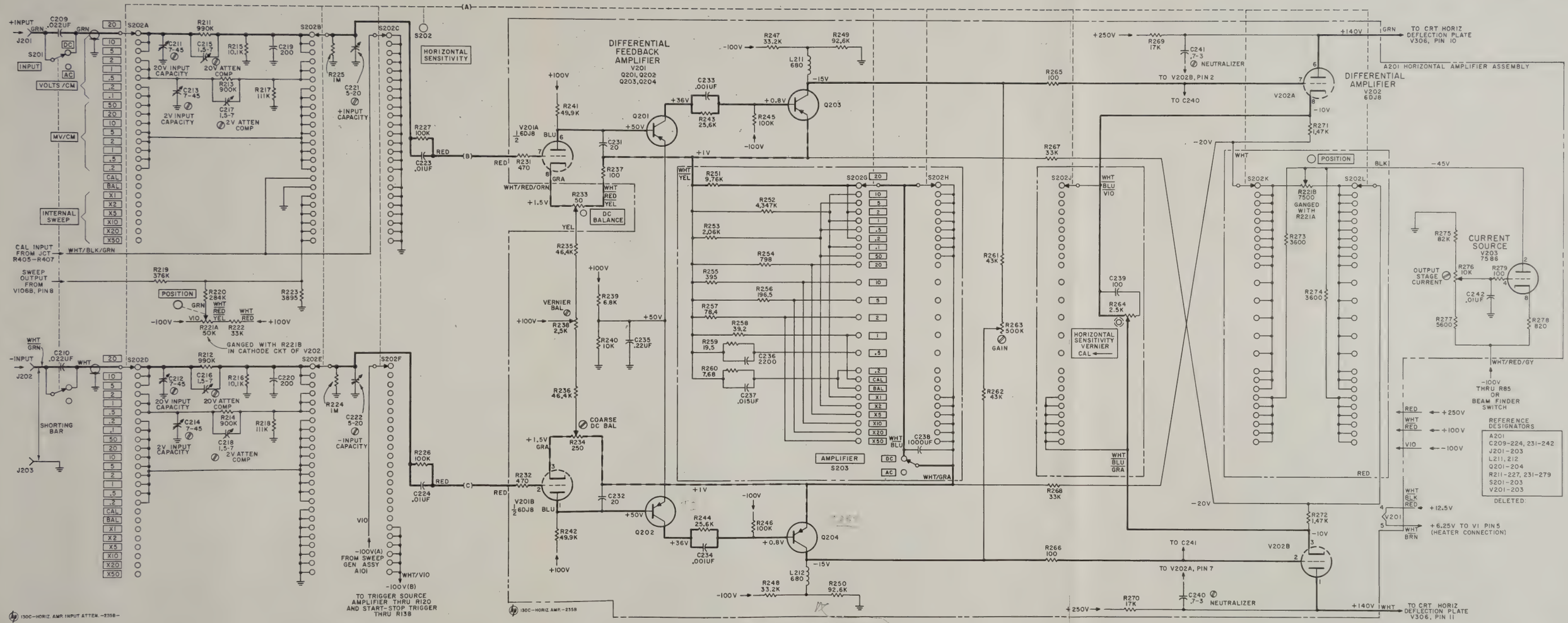


Figure 5-16. Horizontal Attenuator and Amplifier Schematic

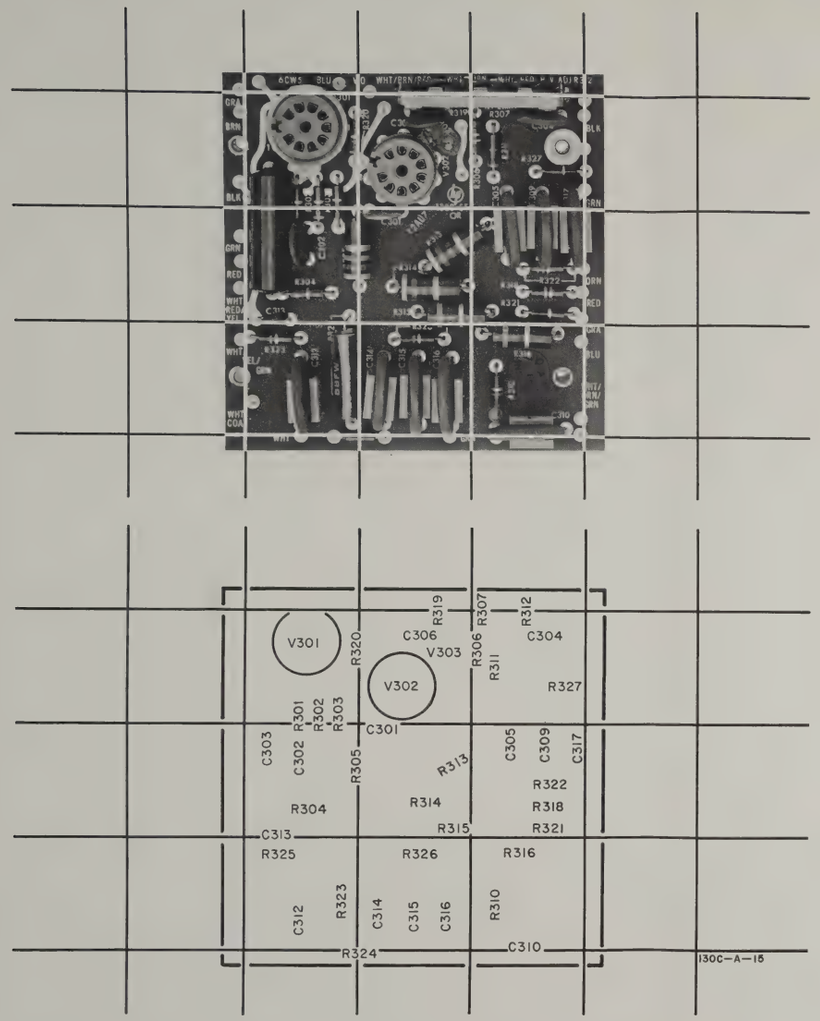


Figure 5-17. High Voltage Power Supply, A301, Component Location

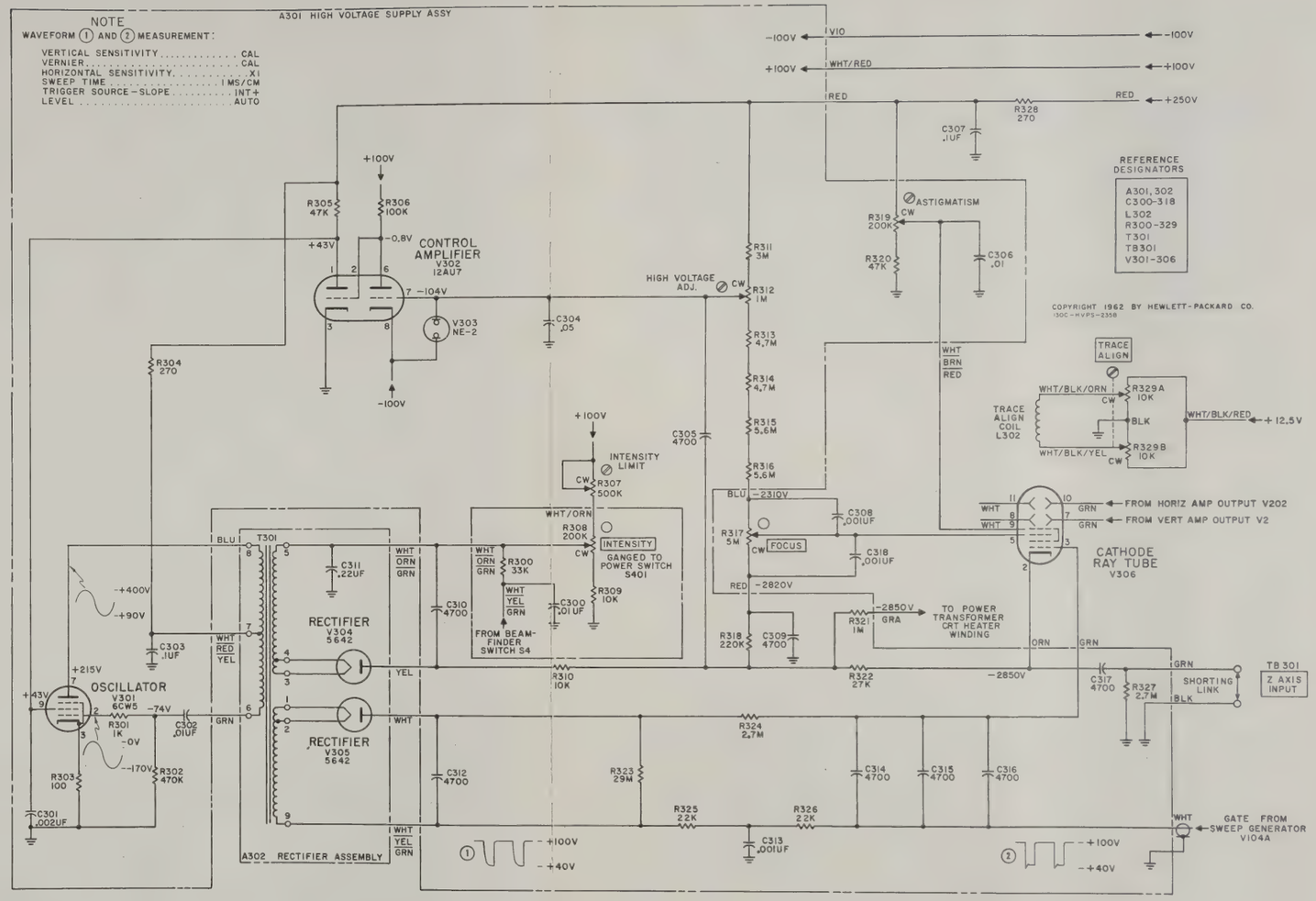
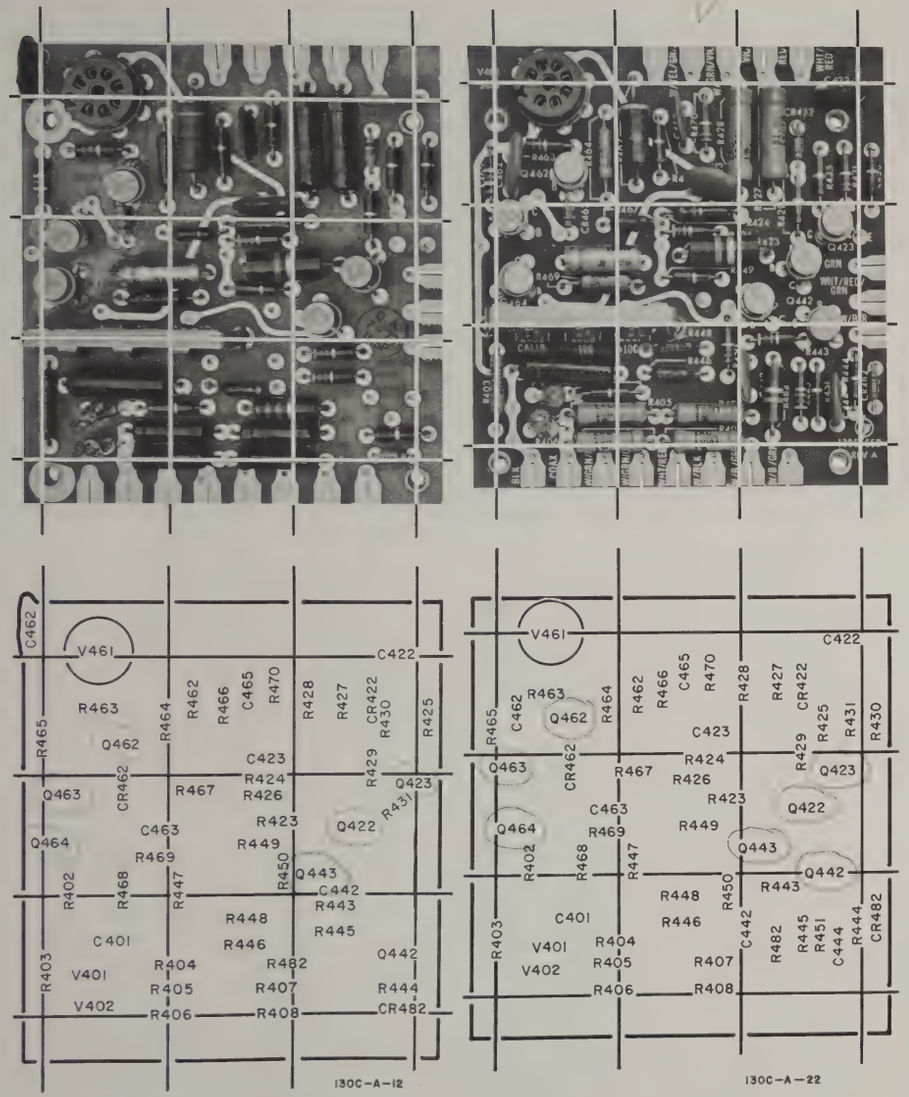


Figure 5-18. High Voltage Power Supply Schematic



(A) For Serial Prefix 235- only

(B) For Serial Prefix 248- and Above

Figure 5-19. Low Voltage Power Supply, A401, Component Location

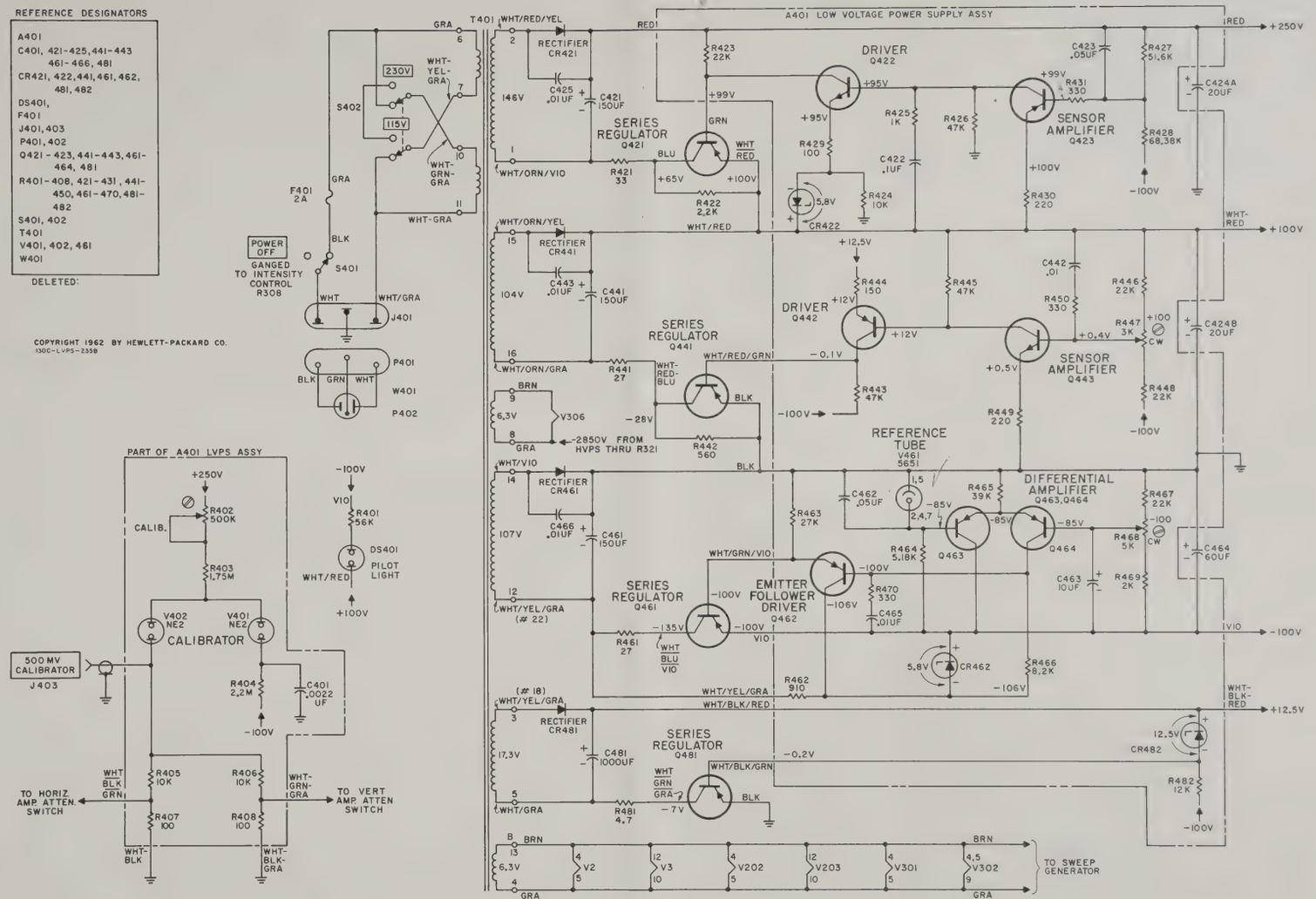


Figure 5-20. Low Voltage Power Supply Schematic
5-25/5-26

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ℗ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ℗ stock numbers and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

d. Total quanity used in the instrument (TQ column).

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry to your local Hewlett-Packard Field Office (see maps at rear of this manual for addresses).

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in Tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	Y	= crystal
DL	= delay line	L	= inductor	S	= switch	Z	= network
DS	= device signaling (lamp)	M	= meter	T	= transformer		
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

A	= amperes	ELECT	= electrolytic	MOM	= momentary	RH	= round head
A.F.C	= automatic frequency control	ENCAP	= encapsulated	MTG	= mounting	RMO	= rack mount only
AMP	= amplifier			MY	= mylar	RMS	= root-mean-square
		F	= farads			ROT	= rotary
B.F.O.	= beat frequency oscillator	FH	= flat head	NC	= normally closed		
BE CU	= beryllium copper	FIL H	= fillister head	NE	= neon	S-B	= slow-blow
BH	= binder head	FXD	= fixed	NI PL	= nickel plate	SE	= selenium
BP	= bandpass			NO	= normally open	SECT	= section(s)
BRS	= brass	GE	= germanium	NPO	= negative positive zero (zero temperature coefficient)	SEMICON	= semiconductor
BWO	= backward wave oscillator	GL	= glass			SI	= silicon
		GRD	= ground(ed)	NSR	= not separately replaceable	SIL	= silver
CER	= ceramic					SL	= slide
CMO	= cabinet mount only	H	= henries			SPL	= special
COEF	= coefficient	HEX	= hexagonal	OBD	= order by description	SST	= stainless steel
COM	= common	HG	= mercury	OH	= oven head		
COMP	= composition	HR	= hour(s)	OX	= oxide	TA	= tantalum
CONN	= connector	IMPG	= impregnated			TD	= time delay
CP	= cadmium plate	INCD	= incandescent	P	= peak	TI	= titanium
CRT	= cathode-ray tube	INS	= insulation(ed)	PC	= printed circuit board	TOG	= toggle
DEPC	= deposited carbon			PF	= picofarads = 10^{-12} farads	TOL	= tolerance
EIA	= Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ℗ stock numbers.	K	= kilo = 1000	PH BRZ	= phosphor bronze	TRIM	= trimmer
				PIV	= peak inverse voltage	TWT	= traveling wave tube
		LIN	= linear taper	POLY	= polystyrene	U	= micro = 10^{-6}
		LK	= lock	POR	= porcelain		
		LOG	= logarithmic taper	POS	= position(s)	VAC	= vacuum
		LPF	= low pass filter	POT	= potentiometer	VAR	= variable
		M	= milli = 10^{-3}	PP	= peak-to-peak		
		MEG	= meg = 10^{6}	PT	= point	W	= watts
		METFLM	= metal film			W/	= with
		MFR	= manufacturer	RECT	= rectifier	W/O	= without
		MINAT	= miniature	RF	= radio frequency	WW	= wirewound

01194-8

Table 6-1. Reference Designation Index

Circuit Reference	Stock No.	Description	Note
A1	130C-65A	ASSY:VERTICAL AMPLIFIER;INCLUDES A5	
A2	130C-19A	ASSY:VERTICAL ATTENUATOR	
A3	3101-0040	SWITCH,SLIDE 2 XDPDT 0.5 AMP.	
A4	2100-0380	R:VAR COMP 2.5K-250 OHM 30% 1/4W	
A5	130C-65F	ASSY:AMPLIFIER INPUT;INCLUDES R43,R44,V1.	
A6 THRU A100		NOT ASSIGNED	
A101	130C-65C	ASSY:SWEEP GENERATOR	
A102	130C-19D	ASSY:TRIGGER SOURCE SWITCH	
A103	3101-0040	SWITCH,SLIDE 2 XDPDT 0.5 AMP	
A104	2100-0347	R:VAR COMP 4 X 25K OHM 30% 1/4W	
A105 THRU A174		NOT ASSIGNED	
A175	130C-19C	ASSY:SWEEP TIME SWITCH	
A176 THRU A200		NOT ASSIGNED	
A201	130C-65B	ASSY:HORIZONAL AMPLIFIER;INCLUDES A205	
A202	130C-19B	ASSY:HORIZONAL ATTENUATOR	
A203	3101-0040	SWITCH,SLIDE 2X DPDT 0.5 AMP	
A204	2100-0380	R:VAR COMP 25K-2500HM 30% 1/4W	
A205	130C-65F	ASSY:AMPLIFIER INPUT;INCLUDES R231,R232,V201.	
A206 THRU A300		NOT ASSIGNED	
A301	130C-65E	ASSY:HV SUPPLY	
A302	130C-11A	ASSY:RECTIFIER;INCLUDES C311,T301,V304,V305.	
A303	2100-0378	R:VAR COMP 1M-500K-200K OHM 30% LIN 1/4W	
A304-400		NOT ASSIGNED	
A401	130C-65D	ASSY:LV SUPPLY	
A402	2100-0377	R:VAR COMP 500K-5K-3K OHM 30% LIN 1/4W	
C9	0160-0003	C:FXD MY 0.022 UF 10% 600VDCW	
C10	0160-0003	C:FXD MY 0.022 UF 10% 600VDCW	
C11	0130-0003	C:VAR CER 1.5-7 PF 500VDCW	
C12	0130-0003	C:VAR CER 1.5-7 PF 500VDCW	
C13	0130-0001	C:VAR CER 7-45 PF 500VDCW	
C14	0130-0001	C:VAR CER 7-45 PF 500VDCW	
C15	0140-0090	C:FXD MICA 200 PF 5% 500VDCW	
C16	0140-0090	C:FXD MICA 200 PF 5% 500VDCW	
C17	0130-0003	C:VAR CER 1.5-7 PF 500VDCW	
C18	0130-0003	C:VAR CER 1.5-7 PF 500VDCW	
C19	0130-0001	C:VAR CER 7-45 PF 500VDCW	
C20	0130-0001	C:VAR CER 7-45 PF 500VDCW	
C21	0130-0006	C:VAR CER 5-20 PF 500VDCW	
C22	0130-0006	C:VAR CER 5-20 PF 500VDCW	
C23	0160-0159	C:FXD MY 6800 PF 10%	
C24	0180-0146	C:FXD ELECT 1000 UF +100-10% 10VDCW	
C25	0150-0084	C:FXD CER 0.1 UF +80-20% 50VDCW	
C26 THRU C40		NOT ASSIGNED	
C41	0150-0012	C:FXD CER 0.01 UF 20% 1000 VDCW	
C42	0150-0012	C:FXD CER 0.01 UF 20% 1000 VDCW	
C43	0150-0035	C:FXD CER 20 PF 10% 600VDCW	
C44	0150-0035	C:FXD CER 20 PF 10% 600VDCW	
C45	0150-0069	C:FXD CER 1000 PF 500VDCW	
C46	0150-0069	C:FXD CER 1000 PF 500VDCW	
C47	0160-0200	C:FXD MY 0.22 UF 20% 200VDCW	
C48	0132-0003	C:VAR POLY 0.7-3.0 PF	
C49	0132-0003	C:VAR POLY 0.7-3.0 PF	
C50	0150-0012	C:FXD CER 0.01 UF 20% 1000 VDCW	
C51	0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	
C52	0140-0041	C:FXD MICA 100 PF 5% 500VDCW	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
C53	0150-0058	C:FXD CER 2.2 PF +/-NPO 600VDCW	
C54 THRU C109		NOT ASSIGNED	
C110	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C111	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C112	0150-0050	C:FXD CER 100 PF 600 VDCW	
C113	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C114	0150-0115	C:FXD CER 27PF 10% 500VDCW	
C115	0140-0005	C:FXD MICA 27 PF 10% 500VDCW	
C116	0140-0146	C:FXD MICA 82 PF 5% 300 VDCW	
C117	0150-0074	C:FXD CER 7 PF +/-.5PF 500 VDCW	
C118	0150-0050	C:FXD CER 100 PF 600 VDCW	
C119	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C120	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C121	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C122 THRU C174		NOT ASSIGNED	
C175	0170-0018	C:FXD MY 1UF 5% 200VDCW	
C176	0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	
C177	0170-0017	C:FXD MY 0.01UF 5% 400VDCW	
C178	0140-0018	C:FXD MICA 1000 PF 5% 500VDCW	
C179	0140-0006	C:FXD 82PF 10% 500VDCW	
C180	0130-0001	C:VAR 7-45 PF 500VDCW	
C181	0130-0006	C:VAR 5-20 PF 500VDCW	
C182 THRU C208		NOT ASSIGNED	
C209	0160-0003	C:FXD MY 0.022UF 10% 600VDCW	
C210	0160-0003	C:FXD MY 0.022UF 10% 600VDCW	
C211	0130-0001	C:VAR 7-45 PF 500VDCW	
C212	0130-0001	C:VAR 7-45 PF 500VDCW	
C213	0130-0001	C:VAR 7-45 PF 500VDCW	
C214	0130-0001	C:VAR 7-45 PF 500VDCW	
C215	0130-0003	C:VAR C 1.5-7PF 500VDCW	
C216	0130-0003	C:VAR C 1.5-7PF 500VDCW	
C217	0130-0003	C:VAR C 1.5-7PF 500VDCW	
C218	0130-0003	C:VAR C 1.5-7PF 500VDCW	
C219	0140-0090	C:FXD MICA 200 PF 5% 500 VDCW	
C220	0140-0090	C:FXD MICA 200 PF 5% 500 VDCW	
C221	0130-0006	C:VAR 5-20 PF 500VDCW	
C222	0130-0006	C:VAR 5-20 PF 500VDCW	
C223	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C224	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C225 THRU C230		NOT ASSIGNED	
C231	0150-0035	C:FXD 20PF 10% 600VDCW	
C232	0150-0035	C:FXD 20PF 10% 600VDCW	
C233	0150-0069	C:FXD 1000PF 500VDCW	
C234	0150-0069	C:FXD 1000PF 500VDCW	
C235	0160-0200	C:FXD MYLAR 0.22UF 20% 200VDCW	
C236	0160-0154	C:FXD 2200PF 10%	
C237	0160-0194	C:FXD 0.015UF 10%	
C238	0180-0146	C:FXD ELECT 1000UF -10+100% 10VDCW	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
C239	0140-0041	C:FXD MICA 100 PF 5% 500 VDC#	
C240	0132-0003	C:VAR POLY 0.7-3.0 PF	
C241	0132-0003	C:VAR POLY 0.7-3.0 PF	
C242	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C243 THRU			
C299		NOT ASSIGNED	
C300	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C301	0150-0023	C:FXD CER 2000PF 20% 1000VDC#	
C302	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C303	0160-0013	C:FXD MY 0.1UF 10% 400VDCW	
C304	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C305	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C306	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C307	0160-0013	C:FXD MY 0.1UF 10% 400VDCW	
C308	0150-0050	C:FXD CER 100 PF 600 VDCW	
C309	0160-0151	C:FXD 4700PF +80% -20% 4000VDC#	
C310	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C311	0160-0018	C:FXD MY 0.22UF 10% 400VDC#	
C312	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C313	0150-0069	C:FXD 1000PF 500VDCW	
C314	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C315	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C316	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C317	0160-0151	C:FXD 4700PF +80% -20% 4000VDCW	
C318	0150-0050	C:FXD CER 100 PF 600 VDCW	
C319 THRU			
C400		NOT ASSIGNED	
C401	0160-0007	C:FXD MY 0.0022UF 10% 600VDC#	
C402 THRU			
C420		NOT ASSIGNED	
C421	0180-0147	C:FXD ELECT 150UF -10+50% 250VDCW	
C422	0150-0084	C:FXD 0.1UF +80-20% 50VDCW	
C423	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C424	0180-0012	C:FXD ELECT 2X20 UF 450VDCW	
C425	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C426 THRU			
C440		NOT ASSIGNED	
C441	0180-0131	C:FXD 150PF +50 -10% 200VDCW	
C442	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C443	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C444	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C445 THRU			
C460		NOT ASSIGNED	
C461	0180-0131	C:FXD 150PF +50 -10% 200VDCW	
C462	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C463	0180-0059	C:FXD 10 UF -10%+100% 25VDC#	
C464	0180-0132	C:FXD 60UF +100 -10% 200VDCW	
C465	0150-0012	C:FXD CER 0.01UF 20% 1000VDC#	
C466	0150-0012	C:FXD CER 0.01UF 20% 1000VDCW	
C467 THRU			
C480		NOT ASSIGNED	
C481	0180-0056	C:FXD ELECT 1000UF 50VDCW	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
CR111	1910-0016	SEMICON DEVICE:DIODE GERMANIUM	
CR112 THRU			
CR420		NOT ASSIGNED	
CR421	1901-0029	DIODE:SILICON PIV 600V I AVG 0.75A	
CR422	1902-0034	SEMICON DEVICE:DIODE	
CR423 THRU			
CR440		NOT ASSIGNED	
CR441	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR442 THRU			
CR460		NOT ASSIGNED	
CR461	1901-0028	DIODE:SILICON PIV 400V I AVGE 0.75A	
CR462	1902-0034	SEMICON DEVICE:DIODE	
CR463 THRU			
CR480		NOT ASSIGNED	
CR481	1901-0045	SEMICON DEVICE:DIODE SILICON	
CR482	1902-0031	SEMICON DEVICE:DIODE	
DS101	2140-0018	LAMP GLOW 1/10W	
DS102 THRU			
DS400		NOT ASSIGNED	
DS401	1450-0048	LAMP:PILOT NE2H	
F401	2110-0002	FUSE:CARTRIDGE 2 AMP 3 AG	
J401	1251-0148	CONNECTOR:POWER	
J402		NOT ASSIGNED	
J403	1251-0202	CONNECTOR, CALIBRATOR	
L11	9140-0157	COIL:FXD RF 680 UH	
L12	9140-0157	COIL:FXD RF 680 UH	
L13 THRU			
L110		NOT ASSIGNED	
L111	9140-0022	COIL:FXD RF 500 UH	
L112 THRU			
L210		NOT ASSIGNED	
L211	9140-0157	COIL:FXD RF 680 UH	
L212	9140-0157	COIL:FXD RF 680 UH	
L213 THRU			
L301		NOT ASSIGNED	
L302	5060-0409	COIL	
P401		NSR, PART OF W401	
P402		NSR, PART OF W401	
Q1	1853-0001	TRANSISTOR:PNP SILICON 30V 900MW	
Q2	1853-0001	TRANSISTOR:PNP SILICON 30V 900MW	
Q3	1850-0097	TRANSISTOR:PNP GE	
Q4	1850-0097	TRANSISTOR:PNP GE	
Q5 THRU			
Q100		NOT ASSIGNED	
Q101	1854-0015	TRANSISTOR:NPN SILICON	
Q102 THRU			
Q200		NOT ASSIGNED	
Q201	1853-0001	TRANSISTOR:PNP SILICON 30V 900MW	
Q202	1853-0001	TRANSISTOR:PNP SILICON 30V 900MW	
Q203	1850-0097	TRANSISTOR:PNP GE	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
Q204	1850-0097	TRANSISTOR:PNP GE	
Q205 THRU			
Q420		NOT ASSIGNED	
Q421	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q422	1851-0017	TRANSISTOR:2N1304	
Q423	1850-0062	TRANSISTOR:GERMANIUM	
Q424 THRU			
Q440		NOT ASSIGNED	
Q441	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q442	1850-0062	TRANSISTOR:GERMANIUM	
Q443	1851-0017	TRANSISTOR:2N1304	
Q444 THRU			
Q460		NOT ASSIGNED	
Q461	1850-0098	TRANSISTOR:GERMANIUM PNP SELECTED	
Q462	1850-0062	TRANSISTOR:GERMANIUM	
Q463	1850-0062	TRANSISTOR:GERMANIUM	
Q464	1850-0062	TRANSISTOR:GERMANIUM	
Q465 THRU			
Q480		NOT ASSIGNED	
Q481	1850-0038	TRANSISTOR:PNP GE	
R11	0727-0269	R:FXD DEPC 990K OHM 1% 1/2W	
R12	0727-0269	R:FXD DEPC 990K OHM 1% 1/2W	
R13	0727-0158	R:FXD 10.1K OHM 1/2W	
R14	0727-0158	R:FXD 10.1K OHM 1/2W	
R15	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	
R16	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	
R17	0727-0210	R:FXD DEPC 111K OHM 1% 1/2W	
R18	0727-0210	R:FXD DEPC 111K OHM 1% 1/2W	
R19	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R20	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R21	0727-0435	R:FXD DEP C 13.47K OHM 1% 1/2W	
R22	0727-0365	R:FXD DEP C 5770 OHMS 1/2% 1/2W	
R23	0727-0431	R:FXD DEP C 2.69K OHM 1% 1/2W	
R24	0727-0101	R:FXD DEPC 1.03K OHM 1% 1/2W	
R25	0727-0437	R:FXD DEP C 509 OHM 1% 1/2W	
R26	0727-0432	R:FXD DEP C 253 OHM 1% 1/2W	
R27	0727-0436	R:FXD DEP C 101 OHM 1% 1/2W	
R28	0727-0433	R:FXD DEP C 50.4 OHM 1% 1/2W	
R29	0727-0434	R:FXD DEP C 25.2 OHM 1% 1/2W	
R30	0727-0430	R:FXD DEP C 91.93 OHM 1% 1/2W	
R31 THRU			
R40		NOT ASSIGNED	
R41	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R42	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R43	0683-4715	R:FXD 470 OHMS 5% 1/4W	
R44	0683-4715	R:FXD 470 OHMS 5% 1/4W	
R45	0811-0084	R:FXD WW 46.4K OHMS 1% 5W	
R46	0811-0084	R:FXD WW 46.4K OHMS 1% 5W	
R47		NSR,PART OF A4	
R48		NSR,PART OF A4	
R49	2100-0138	R:VAR COMP 50 OHMS 10% LIN 2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R50	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R51	0811-0083	R:FXD WW 49.9K OHMS 1% 5W	
R52	0811-0083	R:FXD WW 49.9K OHMS 1% 5W	
R53	0727-0182	R:FXD DEPC 25.6K OHMS 1% 1/2W	
R54	0727-0182	R:FXD DEPC 25.6K OHMS 1% 1/2W	
R55	0689-6825	R:FXD COMP 6800 OHMS 5% 1W	
R56	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R57 THRU			
R60		NOT ASSIGNED	
R61	0727-0208	R:FXD 100K 1% 1/2W	
R62	0727-0208	R:FXD 100K 1% 1/2W	
R63	0727-0186	R:FXD DEPC 33.2K OHMS 1% 1/2W	
R64	0727-0186	R:FXD DEPC 33.2K OHMS 1% 1/2W	
R65	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R66	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R67	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R68	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R69	2100-0382	R:VAR COMP 500K OHM 30% LIN 1/4W	
R70	2100-0373	R:VAR COMP 2500 OHM 10% LIN 0.5W	
R71	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R72	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R73	0727-0374	R:FXD DEP C 33K OHMS 1% 1/2W	
R74	0727-0374	R:FXD DEP C 33K OHMS 1% 1/2W	
R75	0686-2025	R:FXD COMP 2000 OHMS 5% 1/2W	
R76	0767-0017	R:FXD MET FLM 17K OHMS 5% 3W	
R77	0767-0010	R:FXD MET FLM 15K OHMS 5% 3W	
R78	2100-0375	R:VAR COMP 7500 OHM 20% LIN 0.5W	
R79	0727-0109	R:FXD DEPC 1470 OHMS 1% 1/2W	
R80	0727-0109	R:FXD DEPC 1470 OHMS 1% 1/2W	
R81	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R82	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	
R83	2100-0379	R:VAR COMP 10K OHM 30% LIN 1/4W	
R84	0687-8211	R:FXD 820 OHMS 10% 1/2W	
R85	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R86	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R87 THRU			
R110		NOT ASSIGNED	
R111	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R112	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R113	0686-1055	R:FXD COMP 1MEGOHMS 5%1/2W	
R114	0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	
R115	0687-2251	R:FXD COMP 2.2MEGOHMS 10% 1/2W	
R116	2100-0189	R:VAR COMP 1M OHM 30% LIN 1/4W	
R117	0687-4711	R:FXD 470 OHMS 10% 1/2W	
R118	0687-4711	R:FXD 470 OHMS 10% 1/2W	
R119	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R120	0690-3331	R:FXD COMP 33K OHMS 10% 1W	
R121	0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R122	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R123	0687-2751	R:FXD COMP 2.7MEGOHMS 10% 1/2W	
R124	0687-6811	R:FXD 680 OHMS 10% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R125	0687-2721	R:FXD COMP 2700 OHMS 10% 1/2W	
R126	0727-0237	R:FXD DEPC 376K OHM 1% 1/2W	
R127	0727-0244	R:FXD DEPC 500K OHM 1% 1/2W	
R128	0690-2231	R:FXD COMP 22K OHMS 10% 1W	
R129	0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	
R130	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R131	0727-0183	R:FXD DEPC 26.7K OHMS 1% 1/2W	
R132	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R133	0686-4735	R:FXD COMP 47K OHM 5% 1/2W	
R134	0727-0249	R:FXD DEPC 667K OHM 1% 1/2W	
R135	0727-0229	R:FXD 265K OHMS 1% 1/2W	
R136	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R137	0687-1521	R:FXD COMP 1500 OHMS 10% 1/2W	
R138	0687-1531	R:FXD COMP 15K OHMS 10% 1/2W	
R139	0690-1241	R:FXD COMP 120K OHMS 10% 1W	
R140	0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	
R141	0687-8241	R:FXD COMP 820K OHMS 10% 1/2W	
R142	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R143	0686-2445	R:FXD COMP 240K OHMS 5% 1/2W	
R144	0686-2245	R:FXD COMP 220K OHMS 5% 1/2W	
R145	0690-2731	R:FXD COMP 27K OHMS 10% 1W	
R146	2100-0383	R:VAR COMP 5K OHM 30% LIN 1/4W	
R147	0687-8221	R:FXD COMP 8200 OHMS 10% 1/2W	
R148	0687-4751	R:FXD COMP 4.7M OHMS 10% 1/2W	
R149	0686-7525	R:FXD 7500 OHMS 5% 1/2W	
R150	0689-1835	R:FXD COMP 18K OHMS 5% 1W	
R151	2100-0381	R:VAR COMP 25K OHM 30% LIN 1/4W	
R152	0686-2735	R:FXD COMP 27K OHM 5% 1/2W	
R153	0690-4731	R:FXD COMP 47K OHMS 10% 1W	
R154	0687-3301	R:FXD COMP 33 OHMS 10% 1/2W	
R155	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R156	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R157	0686-4715	R:FXD COMP 470 OHMS 5% 1/2W	
R158	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R159	0687-1841	R:FXD COMP 180K OHMS 10% 1/2W	
R160 THRU R174		NOT ASSIGNED	
R175		NSR,PART OF A104	
R176		NSR,PART OF A104	
R177		NSR,PART OF A104	
R178		NSR,PART OF A104	
R179	2100-0107	R:VAR COMP 50K OHMS 30% 1/3W	
R180	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R181	0730-0138	R:FXD 9.0M 1% 1W	
R182	0733-0009	R:FXD DEPC 36M OHMS 1% 2W	
R183	0730-0138	R:FXD 9.0M 1% 1W	
R184	0730-0157	R:FXD DEPC 4.5M OHMS 1% 1W	
R185	0727-0285	R:FXD DEPC 1.8M OHM 1% 1/2W	
R186	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	
R187 THRU R210		NOT ASSIGNED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R211	0727-0269	R:FXD DEPC 990K OHM 1% 1/2W	
R212	0727-0269	R:FXD DEPC 990K OHM 1% 1/2W	
R213	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	
R214	0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	
R215	0727-0158	R:FXD 10.1K OHM 1/2W	
R216	0727-0158	R:FXD 10.1K OHM 1/2W	
R217	0727-0210	R:FXD DEPC 111K OHM 1% 1/2W	
R218	0727-0210	R:FXD DEPC 111K OHM 1% 1/2W	
R219	0727-0237	R:FXD DEPC 376K OHM 1% 1/2W	
R220	0727-0230	R:FXD DEPC 284K OHM 1% 1/2W	
R221	2100-0376	R:VAR COMP 50K OHM-7.5K OHM 20% LINO.5W	
R222	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R223	0727-0130	R:FXD DEPC 3.895K 1/2% 1/2W	
R224	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R225	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R226	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R227	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R228 THRU R230		NOT ASSIGNED	
R231	0683-4715	R:FXD 470 OHMS 5% 1/4W	
R232	0683-4715	R:FXD 470 OHMS 5% 1/4W	
R233	2100-0138	R:VAR COMP 50 OHMS 10% LIN 2W	
R234		NSR; PART OF A204	
R235	0811-0084	R:FXD WW 46.4K OHMS 1% 5W	
R236	0811-0084	R:FXD WW 46.4K OHMS 1% 5W	
R237	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R238		NSR; PART OF A204	
R239	0689-6825	R:FXD COMP 6800 OHMS 5% 1W	
R240	0686-1035	R:FXD COMP 10K OHMS 5%1/2W	
R241	0811-0083	R:FXD WW 49.9K OHMS 1% 5W	
R242	0811-0083	R:FXD WW 49.9K OHMS 1% 5W	
R243	0727-0182	R:FXD DEPC 25.6K OHMS 1% 1/2W	
R244	0727-0182	R:FXD DEPC 25.6K OHMS 1% 1/2W	
R245	0727-0208	R:FXD 100K 1% 1/2W	
R246	0727-0208	R:FXD 100K 1% 1/2W	
R247	0727-0186	R:FXD DEPC 33.2K OHMS 1% 1/2W	
R248	0727-0186	R:FXD DEPC 33.2K OHMS 1% 1/2W	
R249	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R250	0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	
R251	0727-0371	R:FXD DEP C 9760 OHMS 1/2% 1/2W	
R252	0727-0429	R:FXD DEP C 4.347K OHM 1% 1/2W	
R253	0727-0428	R:FXD DEP C 2.06K OHM 1% 1/2W	
R254	0727-0427	R:FXD DEP C 798 OHM 1% 1/2W	
R255	0727-0426	R:FXD DEP C 395 OHM 1% 1/2W	
R256	0727-0425	R:FXD DEP C 196.5 OHM 1% 1/2W	
R257	0727-0424	R:FXD DEP C 78.4 OHM 1% 1/2W	
R258	0727-0423	R:FXD DEP C 39.2 OHM 1% 1/2W	
R259	0727-0422	R:FXD DEP C 19.5 OHM 1% 1/2W	
R260	0727-0421	R:FXD DEP C 7.68 OHM 1% 1/2W	
R261	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	
R262	0686-4335	R:FXD COMP 43K OHMS 5% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R263	2100-0382	R:VAR COMP 500K OHM 30% LIN 1/4W	
R264	2100-0373	R:VAR COMP 2500 OHM 10% LIN 0.5W	
R265	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R266	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R267	0727-0374	R:FXD DEP C 33K OHMS 1% 1/2W	
R268	0727-0374	R:FXD DEP C 33K OHMS 1% 1/2W	
R269	0767-0017	R:FXD MET FLM 17K OHMS 5% 3W	
R270	0767-0017	R:FXD MET FLM 17K OHMS 5% 3W	
R271	0727-0109	R:FXD DEPC 1470 OHMS 1% 1/2W	
R272	0727-0109	R:FXD DEPC 1470 OHMS 1% 1/2W	
R273	0686-3625	R:FXD COMP 3600 OHMS 5% 1/2W	
R274	0686-3625	R:FXD COMP 3600 OHMS 5% 1/2W	
R275	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R276	2100-0379	R:VAR COMP 10K OHM 30% LIN 1/4W	
R277	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	
R278	0687-8211	R:FXD 820 OHMS 10% 1/2W	
R279	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R280	0687-1231	R:FXD COMP 12K OHMS 10% 1/2W	
R281 THRU R299		NOT ASSIGNED	
R300	0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	
R301	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R302	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R303	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R304	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R305	0693-4731	R:FXD COMP 47K OHMS 10% 2W	
R306	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R307		NSR, PART OF A303	
R308	2100-0171	R:VAR COMP 200K OHM 20% LIN 1/4W; INCLUDES S401	
R309	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R310	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R311	0686-3055	R:FXD COMP 3M OHMS 5% 1/2W	
R312		NSR, PART OF A303	
R313	0693-4751	R:FXD COMP 4.7M OHMS 10% 2W	
R314	0693-4751	R:FXD COMP 4.7M OHMS 10% 2W	
R315	0693-5651	R:FXD COMP 5.6M OHMS 10% 2W	
R316	0693-5651	R:FXD COMP 5.6M OHMS 10% 2W	
R317	2100-0374	R:VAR COMP 5M OHM 30% LIN 0.5W	
R318	0687-2241	R:FXD COMP 220K OHMS 10% 1/2W	
R319		NSR, PART OF A303	
R320	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R321	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R322	0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R323	0836-0003	R:FXD DEPC 29M OHMS 10% 1W	
R324	0687-2751	R:FXD COMP 2.7MEGOHMS 10% 1/2W	
R325	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R326	0687-2231	R:FXD COMP 22K OHMS 10% 1/2W	
R327	0687-2751	R:FXD COMP 2.7MEGOHMS 10% 1/2W	
R328	0687-2711	R:FXD COMP 270 OHMS +/-10% 1/2W	
R329	2100-0150	R:VAR GANGED 10K OHM 20% LIN 1/4W	
R330	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R331 THRU R400		NOT ASSIGNED	
R401	0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	
R402		NSR, PART OF A402	
R403	0727-0284	R:FXD DEPC 1.75M OHM 1% 1/2W	
R404	0686-2055	R:FXD COMP 2M OHMS 5% 1/2W	
R405	0727-0157	R:FXD DEPC 10K OHMS 1% 1/2W	
R406	0727-0157	R:FXD DEPC 10K OHMS 1% 1/2W	
R407	0727-0043	R:FXD DEPC 100 OHM 1% 1/2W	
R408	0727-0043	R:FXD DEPC 100 OHM 1% 1/2W	
R409 THRU R420		NOT ASSIGNED	
R421	0687-3301	R:FXD COMP 33 OHMS 10% 1/2W	
R422	0693-2221	R:FXD COMP 2200 OHMS 10% 2W	
R423	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R424	0761-0006	R:FXD MET FLM 10K OHM 5% 1W	
R425	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R426	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R427	0730-0052	R:FXD DEPC 51.6K OHMS 1% 1W	
R428	0730-0056	R:FXD DEPC 68.38K OHMS 1% 1W	
R429	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R430	0687-2211	R:FXD 220 OHMS 10% 1/2W	
R431	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R432 THRU R440		NOT ASSIGNED	
R441	0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	
R442	0767-0002	R:FXD MET FLM 560 OHMS 5% 3W	
R443	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R444	0687-1511	R:FXD COMP 150 OHMS 10% 1/2W	
R445	0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	
R446	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R447		NSR, PART OF A402	
R448	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R449	0687-2211	R:FXD 220 OHMS 10% 1/2W	
R450	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R451	0687-1021	R:FXD COMP 1000 OHMS 10% 1/2W	
R452 THRU R460		NOT ASSIGNED	
R461	0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	
R462	0764-0023	R:FXD MET FLM 910 OHM 5% 2W	
R463	0687-2731	R:FXD COMP 27K OHMS 10% 1/2W	
R464	0727-0137	R:FXD DEPC 5.18K OHMS 1% 1/2W	
R465	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R466	0687-8221	R:FXD COMP 8200 OHMS 10% 1/2W	
R467	0758-0020	R:FXD MET FLM 22K OHMS 5% 1/2W	
R468		NSR, PART OF A402	
R469	0727-0115	R:FXD DEPC 2000 OHMS 1% 1/2W	
R470	0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	
R471 THRU R480		NOT ASSIGNED	
R481	0699-0006	R:FXD COMP 4.7 OHM 10% 1W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
R482	0690-1231	R:FXD 12K OHMS 10% 1W	
S1		NSR, PART OF A2	
S2		NSR, PART OF A3	
S3		NSR, PART OF A3	
S4	3101-0014	SWITCH:PUSH SPDT NE	
S5 THRU			
S100		NOT ASSIGNED	
S101		NSR , PART OF A102	
S102		NSR , PART OF A102	
S103		NSR, PART OF A103	
S104		NSR, PART OF A103	
S105 THRU			
S174		NOT ASSIGNED	
S175		NSR , PART OF A175	
S176 THRU			
S200		NOT ASSIGNED	
S201		NSR, PART OF A203	
S202		NSR, PART OF A202	
S203		NSR, PART OF A203	
S204 THRU			
S400		NOT ASSIGNED	
S401		NSR, PART OF R308	
S402	3101-0033	SWITCH:SLIDE	
T301	130C-11A-1	TRANSFORMER: HV	
T302 THRU			
T400		NOT ASSIGNED	
T401	9100-0169	TRANSFORMER:POWER	
TB301	0360-0104	STRIP:TERMINAL	
V1	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V2	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V3	1921-0017	ELECTRON TUBE: 7586 NUVISTOR TRIODE	
V4 THRU			
V100		NOT ASSIGNED	
V101	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V102	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V103	1933-0008	ELECTRON TUBE: 6BL8 TRIODE PENTODE	
V104	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V105	2140-0006	LAMP:NEON NE2	
V106	1933-0008	ELECTRON TUBE: 6BL8 TRIODE PENTODE	
V107	5080-0419	NEON- AGED (GREEN)	
V108	2140-0008	LAMP:NEON NE2	
V109	1939-0002	ELECTRON TUBE: 6BC7 TRIPLE DIODE 9 PIN	
V110 THRU			
V200		NOT ASSIGNED	
V201	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V202	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V203	1921-0017	ELECTRON TUBE: 7586 NUVISTOR TRIODE	
V204 THRU			
V300		NOT ASSIGNED	
V301	1923-0044	ELECTRON TUBE: 6CW5 (EL 86) PENTODE	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
V302	1932-0029	ELECTRON TUBE: 12 AU7 DUAL TRIODE	
V303	2140-0008	LAMP:NEON NE2	
V304	1920-0001	ELECTRON TUBE: 5642	
V305	1920-0001	ELECTRON TUBE: 5642	
V306	5083-0353	TUBE: CATHODE RAY;P31 PHOSPHOR(SEE OPTIONS)	
V307 THRU V400		NOT ASSIGNED	
V401	5080-0419	NEON- AGED (GREEN)	
V402	5080-0419	NEON- AGED (GREEN)	
V403 THRU V460		NOT ASSIGNED	
V461	1940-0001	TUBE:ELECTRON 5651	
W401	8120-0078	CABLE: POWER 7.5 FT.	
XQ421	1200-0044	SOCKET-TRANSISTOR	
XQ422 THRU XQ440		NOT ASSIGNED	
XQ441	1200-0044	SOCKET-TRANSISTOR	
XQ442 THRU XQ460		NOT ASSIGNED	
XQ461	1200-0044	SOCKET-TRANSISTOR	
XQ462 THRU XQ480		NOT ASSIGNED	
XQ481	1200-0044	SOCKET-TRANSISTOR	
XV1	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV2	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV3	1200-0086	SOCKET:NUVISTOR 5-PIN	
XV4 THRU XV100		NOT ASSIGNED	
XV101	1200-0059	SOCKET-TUBE	
XV102	1200-0062	SOCKET-TUBE	
XV103	1200-0062	SOCKET-TUBE	
XV104	1200-0062	SOCKET-TUBE	
XV105		NOT ASSIGNED	
XV106	1200-0062	SOCKET-TUBE	
XV107 THRU XV108		NOT ASSIGNED	
XV109	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV110 THRU XV200		NOT ASSIGNED	
XV201	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV202	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV203	1200-0086	SOCKET:NUVISTOR 5-PIN	
XV204 THRU XV300		NOT ASSIGNED	
XV301	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV302	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV303 THRU XV305		NOT ASSIGNED	
XV306	1200-0037	SOCKET:CRT TUBE	
XV307 THRU XV460		NOT ASSIGNED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Circuit Reference	Stock No.	Description	Note
XV461	1200-0053	SOCKET:TUBE 7 PIN MINIATURE	
		MISCELLANEOUS	
	130C-6C	COVER:HV TOP	
	130C-6D	COVER:HV BOTTOM	
	130C-44A-1	COVER:TOP	
	0370-0026	KNOB:BLACK,POSITION	
	0370-0037	KNOB:BLACK,SENSITIVITY SWEEP TIME	
	0370-0062	KNOB:RED,VERNIER	
	0370-0084	KNOB:BLACK,BALANCE FOCUS INTENSITY	
	0370-0113	KNOB:BLACK BAR	
	0370-0114	KNOB:RED,TRIGGER LEVEL	
	1220-0009	SHIELD:TUBE	
	1490-0030	STAND:TILT	
	1510-0010	BINDING POST:RED,INPUT	
	1510-0011	BINDING POST:BLACK,TRIGGER GROUND	
	5000-0743	SIDE COVER:7 X 16 FM	
	5060-0627	ASSY:CONNECTOR,INPUT GROUND	
	5060-0761	BOTTOM COVER ASSY:16L FM	
	5060-0763	HANDLE ASSY.-SIDE	
	5060-0765	RETAINER:HANDLE ASSY.	
	5060-0767	FOOT ASSY-FM	
	5060-0776	KIT:RACK MOUNT	
	6980-0003	TRIM:PLASTIC	
		OPTIONS	
	5083-0323	02: CRT WITH P2 PHOSPHOR 05: ORDER PARTS BY DESCRIPTION 06: REAR PANEL INPUT CONNECTORS	
	1251-0038	AN-TYPE CONNECTOR,FEMALE	
	1251-0039	AN-TYPE CONNECTOR,MALE	
	1250-0083	BNC-TYPE CONNECTOR,FEMALE	
	5083-0333	07: CRT WITH P7 PHOSPHOR	
	5083-0432	11: CRT WITH P11 PHOSPHOR 13: ORDER PARTS BY DESCRIPTION	

See introduction to this section

Table 6-2 Replaceable Parts

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
130C-6C	COVER:HV TOP	28480	130C-6C	1	0
130C-6D	COVER:HV BOTTOM	28480	130C-6D	1	0
130C-11A	ASSY:RECTIFIER	28480	130C-11A	1	0
130C-11A-1	TRANSFORMER:HV	28480	130C-11A-1	1	1
130C-19A	ASSY:VERTICAL ATTENUATOR	28480	130C-19A	1	1
130C-19B	ASSY:HORIZONAL ATTENUATOR	28480	130C-19B	1	1
130C-19C	ASSY:SWEEP TIME SWITCH	28480	130C-19C	1	1
130C-19D	ASSY:TRIGGER SOURCE SWITCH	28480	130C-19D	1	1
130C-44A-1	COVER:TOP	28480	130C-44A-1	1	1
130C-65A	ASSY:VERTICAL AMPLIFIER	28480	130C-65A	1	0
130C-65B	ASSY:HORIZONAL AMPLIFIER	28480	130C-65B	1	0
130C-65C	ASSY:SWEEP GENERATOR	28480	130C-65C	1	0
130C-65D	ASSY:LV SUPPLY	28480	130C-65D	1	0
130C-65E	ASSY:HV SUPPLY	28480	130C-65E	1	0
130C-65F	ASSY:AMPLIFIER INPUT	28480	130C-65F	2	0
0130-0001	C:VAR CER 7-45 PF 500VDCW	72982	503 00D 2P0	9	2
0130-0003	C:VAR CER 1.5-7 PF 500VDCW	72982	503 000 C0P0-10R	8	2
0130-0006	C:VAR CER 5-20 PF 500VDCW	72982	B2 P028R	5	1
0132-0003	C:VAR POLY 0.7-3.0 PF 350VDCW	72982	535 016 4R	4	1
0140-0005	C:FXD MICA 27 PF 10% 500VDCW	00853	TYPE DR 1427 B10	1	1
0140-0006	C:FXD MICA 82 PF 10% 500VDCW	76433	RCM 15B 820K	1	1
0140-0018	C:FXD MICA 1000 PF 5% 500VDCW	00853	TYPE KR120 E5	1	1
0140-0041	C:FXD MICA 100 PF 5% 500VDCW	00853	TYPE DR1310 E5	2	1
0140-0090	C:FXD MICA 200 PF 5% 500VDCW	00853	TYPE DR1320 E5	4	1
0140-0146	C:FXD MICA 82 PF 5% 300VDCW	04062	DM 15F 820J	1	1
0150-0012	C:FXD CER 0.01 UF 20% 1000VDCW	56289	H1038	18	3
0150-0023	C:FXD CER 2000 PF 20% 1000VDCW	91418	TYPE JF .002 20%	1	1
0150-0035	C:FXD CER 20 PF 10% 600VDCW	71590	DD200	4	1
0150-0050	C:FXD CER 100 PF 600VDCW	000RR	TYPE E	4	1
0150-0052	C:FXD CER 0.05 UF 20% 400VDCW	05729	20X503 MC4	7	2
0150-0058	C:FXD CER 2.2 PF +/-NP0 600VDCW	72982	301 000 C0J0 229C	1	1
0150-0069	C:FXD CER 1000 PF 500VDCW	72982	801010X5	5	1
0150-0074	C:FXD CER 7 PF +/-.5PF 500VDCW	72982	301 000 C0H0 709D	1	1
0150-0084	C:FXD CER 0.1 UF +80-20% 50VDCW	56289	33C41	2	1
0150-0115	C:FXD CER 27 PF 10% 500VDCW	71590	CC20 TCN 27	1	1
0160-0003	C:FXD MY 0.022 UF 10% 600VDCW	56289	160P 22396	4	1
0160-0007	C:FXD MY 0.0022 UF 10% 600VDCW	56289	160P 22296	1	1
0160-0013	C:FXD MY 0.1 UF 10% 400VDCW	56289	160P 10494	2	1
0160-0018	C:FXD MY 0.22 UF 10% 400VDCW	56289	160P 22494	1	1
0160-0151	C:FXD CER 4700 PF 20% 4000VDCW	71590	DA 172-097CB	8	2
0160-0154	C:FXD MY 2200 PF 10%	28480	0160-0154	1	1
0160-0159	C:FXD MY 6800 PF 10%	28480	0160-0159	1	1
0160-0194	C:FXD MY 0.015 UF 10%	56289	192P15392	1	1
0160-0200	C:FXD MY 0.22 UF 20% 200VDCW	28480	0160-0200	2	1
0170-0017	C:FXD MY 0.01 UF 5% 400VDCW	84411	TYPE 620S/0.01	1	1
0170-0018	C:FXD MY 1 UF 5% 200VDCW	84411	HEW 4	1	1
0170-0019	C:FXD MY 0.1 UF 5% 200VDCW	28480	0170-0019	1	1
0180-0012	C:FXD ELECT 2 X20 UF 450VDCW	56289	D32440	1	1
0180-0056	C:FXD ELECT 1000 UF 50VDCW	56289	D32429	1	1

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0180-0059	C:FXD ELECT 10 UF +100-10% 25VDCW	56289	30D182A1	1	1
0180-0131	C:FXD ELECT 150 PF +50-10% 200VDCW	00853	PL1	2	1
0180-0132	C:FXD ELECT 60 UF +100-10% 200VDCW	00853	PL1	1	1
0180-0146	C:FXD ELECT 1000 UF +100-10% 10VDCW	56289	D35387	2	1
0180-0147	C:FXD ELECT 150 UF +50-10% 250VDCW	00853	PL1	1	1
0360-0104	STRIP:TERMINAL	28480	0360-0104	1	1
0370-0026	KNOB:BLACK	28480	0370-0026	1	0
0370-0037	KNOB:BLACK BAR	28480	0370-0037	2	0
0370-0062	KNOB:RED	28480	0370-0062	1	0
0370-0084	KNOB:BLACK	28480	0370-0084	1	0
0370-0113	KNOB:BLACK BAR	28480	0370-0113	1	0
0370-0114	KNOB:RED	28480	0370-0114	1	0
0683-4715	R:FXD COMP 470 OHM 5% 1/4W	01121	CB 4715	4	1
0686-1035	R:FXD COMP 10K OHM 5% 1/2W	01121	EB 1035	2	1
0686-1055	R:FXD COMP 1 MEGOHM 5% 1/2W	01121	EB 1055	1	1
0686-2025	R:FXD COMP 2000 OHM 5% 1/2W	01121	EB 2025	1	1
0686-2055	R:FXD COMP 2 MEGOHM 5% 1/2W	01121	EB 2055	1	1
0686-2245	R:FXD COMP 220K OHM 5% 1/2W	01121	EB 2245	1	1
0686-2445	R:FXD COMP 240K OHM 5% 1/2W	01121	EB 2445	1	1
0686-2735	R:FXD COMP 27K OHM 5% 1/2W	01121	EB 2735	1	1
0686-3055	R:FXD COMP 3 MEGOHM 5% 1/2W	01121	EB 3055	1	1
0686-3625	R:FXD COMP 3600 OHM 5% 1/2W	01121	EB 3625	2	1
0686-4335	R:FXD COMP 43K OHM 5% 1/2W	01121	EB 4335	4	1
0686-4715	R:FXD COMP 470 OHM 5% 1/2W	01121	EB 4715	1	1
0686-4735	R:FXD COMP 47K OHM 5% 1/2W	01121	EB 4735	1	1
0686-7525	R:FXD COMP 7500 OHM 5% 1/2W	01121	EB 7525	1	1
0687-1011	R:FXD COMP 100 OHM 10% 1/2W	01121	EB 1011	16	4
0687-1021	R:FXD COMP 1000 OHM 10% 1/2W	01121	EB 1021	3	1
0687-1031	R:FXD COMP 10K OHM 10% 1/2W	01121	EB 1031	4	1
0687-1041	R:FXD COMP 100K OHM 10% 1/2W	01121	EB 1041	7	2
0687-1051	R:FXD COMP 1 MEGOHM 10% 1/2W	01121	EB 1051	2	1
0687-1231	R:FXD COMP 12K OHM 10% 1/2W	01121	EB 1231	1	1
0687-1511	R:FXD COMP 150 OHM 10% 1/2W	01121	EB 1511	1	1
0687-1521	R:FXD COMP 1500 OHM 10% 1/2W	01121	EB 1521	1	1
0687-1531	R:FXD COMP 15K OHM 10% 1/2W	01121	EB 1531	1	1
0687-1841	R:FXD COMP 180K OHM 10% 1/2W	01121	EB 1841	1	1
0687-2211	R:FXD COMP 220 OHM 10% 1/2W	01121	EB 2211	2	1
0687-2231	R:FXD COMP 22K OHM 10% 1/2W	01121	EB 2231	3	1
0687-2241	R:FXD COMP 220K OHM 10% 1/2W	01121	EB 2241	1	1
0687-2251	R:FXD COMP 2.2 MEGOHM 10% 1/2W	01121	EB 2251	1	1
0687-2701	R:FXD COMP 27 OHM 10% 1/2W	01121	EB 2701	2	1
0687-2711	R:FXD COMP 270 OHM 10% 1/2W	01121	EB 2711	4	1
0687-2721	R:FXD COMP 2700 OHM 10% 1/2W	01121	EB 2721	1	1
0687-2731	R:FXD COMP 27K OHM 10% 1/2W	01121	EB 2731	3	1
0687-2751	R:FXD COMP 2.7 MEGOHM 10% 1/2W	01121	EB 2751	3	1
0687-3301	R:FXD COMP 33 OHM 10% 1/2W	01121	EB 3301	2	1

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0687-3311	R:FXD COMP 330 OHMS 10% 1/2W	01121	EB 3311	3	1
0687-3331	R:FXD COMP 33K OHMS 10% 1/2W	01121	EB 3331	2	1
0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	01121	EB 3341	1	0
0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	01121	EB 3931	1	1
0687-4711	R:FXD 470 OHMS 10% 1/2W	01121	EB-4711	2	1
0687-4721	R:FXD COMP 4700 OHMS 10% 1/2W	01121	EB4721	1	1
0687-4731	R:FXD COMP 47K OHMS 10% 1/2W	01121	EB 4731	4	1
0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	01121	EB 4741	1	1
0687-4751	R:FXD COMP 4.7M OHMS 10% 1/2W	01121	EB 4751	1	1
0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	01121	EB 5621	2	1
0687-5631	R:FXD COMP 56K OHMS 10% 1/2W	01121	EB 5631	2	1
0687-6811	R:FXD 680 OHMS 10% 1/2W	01121	EB6811	1	0
0687-8211	R:FXD 820 OHMS 10% 1/2W	01121	EB-8211	2	1
0687-8221	R:FXD COMP 8200 OHMS 10% 1/2W	01121	EB 8221	2	1
0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	01121	EB 8231	2	1
0687-8241	R:FXD COMP 820K OHMS 10% 1/2W	01121	EB 8241	1	1
0689-1835	R:FXD COMP 18K OHMS 5% 1W	01121	GB 1835	1	1
0689-6825	R:FXD COMP 6800 OHMS 5% 1W	01121	GB 6825	2	1
0690-1231	R:FXD 12K OHMS 10% 1W	01121	GB-1231	1	1
0690-1241	R:FXD COMP 120K OHMS 10% 1W	01121	GB 1241	1	1
0690-2231	R:FXD COMP 22K OHMS 10% 1W	01121	GB 2231	1	1
0690-2731	R:FXD COMP 27K OHMS 10% 1W	01121	GB 2731	1	1
0690-3331	R:FXD COMP 33K OHMS 10% 1W	01121	GB 3331	1	1
0690-4731	R:FXD COMP 47K OHMS 10% 1W	01121	GB 4731	1	1
0693-2221	R:FXD COMP 2200 OHMS 10% 2W	01121	HB 2221	1	1
0693-2231	R:FXD COMP 22K OHMS 10% 2W	01121	HB 2231	1	1
0693-4731	R:FXD COMP 47K OHMS 10% 2W	01121	HB 4731	1	1
0693-4751	R:FXD COMP 4.7M OHMS 10% 2W	01121	HB 4751	2	1
0693-5651	R:FXD COMP 5.6M OHMS 10% 2W	01121	HB 5651	2	1
0699-0006	R:FXD COMP 4.7 OHM 10% 1W	01121	GB 47G1	1	3
0727-0043	R:FXD DEPC 100 OHM 1% 1/2W	19701	DC 1/2 BR5	2	1
0727-0101	R:FXD DEPC 1.03K OHM 1% 1/2W	19701	CD 1/2CR5	1	0
0727-0109	R:FXD DEPC 1470 OHMS 1% 1/2W	19701	DC 1/2CR5	4	1
0727-0115	R:FXD DEPC 2000 OHMS 1% 1/2W	19701	DC 1/2CR5	1	1
0727-0130	R:FXD DEPC 3.895K 1/2% 1/2W	19701	DC 1/2AR5	1	0
0727-0137	R:FXD DEPC 5.18K OHMS 1% 1/2W	19701	DC 1/2CR5	1	1
0727-0157	R:FXD DEPC 10K OHMS 1% 1/2W	19701	DC 1/2BR5	2	1
0727-0158	R:FXD 10.1K OHM 1/2W	19701	DC 1/2CR5	4	1
0727-0182	R:FXD DEPC 25.6K OHMS 1% 1/2W	19701	DC 1/2CR5	4	1
0727-0183	R:FXD DEPC 26.7K OHMS 1% 1/2W	19701	DC 1/2BR5	1	1
0727-0186	R:FXD DEPC 33.2K OHMS 1% 1/2W	19701	DC 1/2CR5	4	1
0727-0205	R:FXD DEPC 92.6K OHM 1% 1/2W	19701	DC 1/2C R5	4	1
0727-0208	R:FXD 100K 1% 1/2W	19701	DC1/2CR5	4	1
0727-0210	R:FXD DEPC 111K OHM 1% 1/2W	19701	DC 1/2A R5	4	0
0727-0229	R:FXD 265K OHMS 1% 1/2W	19701	DC1/2AR5	1	1
0727-0230	R:FXD DEPC 284K OHM 1% 1/2W	19701	DC1/2CRS-2843 F	1	0
0727-0237	R:FXD DEPC 376K OHM 1% 1/2W	19701	CD 1/2C R5	2	1
0727-0244	R:FXD DEPC 500K OHM 1% 1/2W	19701	DC 1/2A R5	1	1
0727-0249	R:FXD DEPC 667K OHM 1% 1/2W	19701	DC 1/2C R5	1	1
0727-0259	R:FXD DEPC 900K OHM 1% 1/2W	19701	DC 1/2A R5	5	1

See introduction to this section

Table 6-2. **Replaceable Parts** (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0727-0269	R:FXD DEPC 990K OHM 1% 1/2W	19701	DC 1/2 AR5	4	1
0727-0274	R:FXD DEPC 1 MEGOHM 1% 1/2W	19701	DC 1/2 R5	4	1
0727-0284	R:FXD DEPC 1.75 MEGOHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0285	R:FXD DEPC 1.8 MEGOHM 1% 1/2W	19701	DC 1/2 CR5	1	1
0727-0365	R:FXD DEPC 5770 OHM 1/2% 1/2W	19701	DC 1/2 AR5	1	1
0727-0371	R:FXD DEPC 9760 OHM 1/2% 1/2W	19701	DC 1/2 AR5	1	1
0727-0374	R:FXD DEPC 33K OHM 1% 1/2W	19701	CF 1/2	4	1
0727-0421	R:FXD DEPC 7.68 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0422	R:FXD DEPC 19.5 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0423	R:FXD DEPC 39.2 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0424	R:FXD DEPC 78.4 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0425	R:FXD DEPC 196.5 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0426	R:FXD DEPC 395 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0427	R:FXD DEPC 798 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0428	R:FXD DEPC 2.06K OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0429	R:FXD DEPC 4.347K OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0430	R:FXD DEPC 91.93 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0431	R:FXD DEPC 2.69K OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0432	R:FXD DEPC 253 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0433	R:FXD DEPC 50.4 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0434	R:FXD DEPC 25.2 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0435	R:FXD DEPC 13.47K OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0436	R:FXD DEPC 101 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0727-0437	R:FXD DEPC 509 OHM 1% 1/2W	19701	DC 1/2 AR5	1	1
0730-0052	R:FXD DEPC 51.6K OHM 1% 1W	19701	DC 1 R5	1	1
0730-0056	R:FXD DEPC 68.38K OHM 1% 1W	19701	DC 1 R5	1	1
0730-0138	R:FXD DEPC 9.0 MEGOHM 1% 1W	19701	DC 1 R5	2	1
0730-0157	R:FXD DEPC 4.5 MEGOHM 1% 1W	19701	DC 1 R5	1	1
0733-0009	R:FXD DEPC 36 MEGOHM 1% 2W	19701	DC 2 R5	1	1
0758-0020	R:FXD MET FLM 22K OHM 5% 1/2W	07115	C20	3	1
0761-0006	R:FXD MET FLM 10K OHM 5% 1W	07115	C32	1	1
0764-0023	R:FXD MET FLM 910 OHM 5% 2W	07115	C42S	1	1
0767-0002	R:FXD MET FLM 560 OHM 5% 3W	07115	LPI 3	1	1
0767-0010	R:FXD MET FLM 15K OHM 5% 3W	07115	LPI 3	1	1
0767-0017	R:FXD MET FLM 17K OHM 5% 3W	07115	LPI 3	3	1
0811-0083	R:FXD WW 49.9K OHM 1% 5W	75042	AS 5	4	1
0811-0084	R:FXD WW 46.4K OHM 1% 5W	75042	AS 5	4	1
0836-0003	R:FXD DEPC 29 MEGOHM 10% 1W	77764	TYPE BBF	1	1
1200-0037	SOCKET:CRT TUBE	72825	97094	1	1
1200-0044	SOCKET:TRANSISTOR	97464	M7 (PB)	4	1
1200-0053	SOCKET:TUBE 7 PIN MINIATURE	71785	11151-11	1	1
1200-0059	SOCKET:TUBE	71785	121-51-11-082	5	1
1200-0062	SOCKET:TUBE 9 PIN MINIATURE	71785	121 51-11-060	11	2
1200-0086	SOCKET:NUVISTOR 5 PIN	71785	133 65 10 009	2	1
1220-0009	SHIELD:TUBE	71785	12627	1	1
1251-0148	CONNECTOR:POWER	60427	H 10611 G-3L	1	1
1251-0202	CONNECTOR:BANANA JACK	83330	221B	1	1
1450-0048	LAMP:PILOT NE2H	08717	858 R	1	1
1490-0030	STAND:TILT	28480	1490-0030	1	0
1510-0010	BINDING POST:RED	28480	1510-0010	1	0
1510-0011	BINDING POST:BLACK	28480	1510-0011	1	0
1850-0038	TRANSISTOR:GE PNP	86684	34879	1	1

See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
1850-0062	TRANSISTOR:GE	28480	1850-0062	5	5
1850-0097	TRANSISTOR:GE PNP	73445	2N2084	4	4
1850-0098	TRANSISTOR:GE PNP SELECTED	28480	1850-0098	3	3
1851-0017	TRANSISTOR:2N1304	01295	2N1304	2	2
1853-0001	TRANSISTOR:SI PNP 30V	28480	1853-0001	4	4
1854-0015	TRANSISTOR:SI NPN	28480	1854-0015	1	1
1901-0028	SEMICON DEVICE:DIODE SI	28480	1901-0028	2	2
1901-0029	SEMICON DEVICE:DIODE SI	28480	1901-0029	1	1
1901-0045	SEMICON DEVICE:DIODE SI	28480	1901-0045	1	1
1902-0031	SEMICON DEVICE:DIODE	28480	1902-0031	1	1
1902-0034	SEMICON DEVICE:DIODE	28480	1902-0034	2	2
1910-0016	SEMICON DEVICE:DIODE GE	93332	D2361	1	1
1920-0001	ELECTRON TUBE:5642	82219	5642	2	2
1921-0017	ELECTRON TUBE:7586	86684	7586	2	2
1923-0044	ELECTRON TUBE:6CW5	73445	EL 86/6CW5	1	1
1932-0022	ELECTRON TUBE:DUAL TRIODE	13396	6DJ8/ECC 88	7	7
1932-0029	ELECTRON TUBE:12AU7	12859	12AU7	1	1
1933-0008	ELECTRON TUBE:6BL8	73445	6BL8/ECF 80	2	2
1939-0002	ELECTRON TUBE:6BC7	93332	6BC7	1	1
1940-0001	ELECTRON TUBE:5651	86684	5651	1	1
2100-0107	R:VAR COMP 50K OHM 30% 1/3W	28480	2100-0107	1	1
2100-0138	R:VAR COMP 50 OHM 10% LIN 2W	28480	2100-0138	2	1
2100-0150	R:VAR GANGED 10K OHM 20% LIN 1/4W	28480	2100-0150	1	1
2100-0171	R:VAR COMP 200K OHM 20% LIN 1/4W	28480	2100-0171	1	1
2100-0189	R:VAR COMP 1 MEGOHM 30% LIN 1/4W	28480	2100-0189	1	1
2100-0347	R:VAR COMP 4 X 25 K OHM 30% 1/4W	71590	2100-0347	1	1
2100-0373	R:VAR COMP 2500 OHM 10% LIN 0.5W	28480	2100-0373	2	1
2100-0374	R:VAR COMP 5 MEGOHM 30% LIN 0.5W	28480	2100-0374	1	1
2100-0375	R:VAR COMP 7500 OHM 20% LIN 0,5W	28480	2100-0375	1	1
2100-0376	R:VAR COMP 50K OHM-7.5K OHM 20% 0.5W	28480	2100-0376	1	1
2100-0377	R:VAR COMP 500K-5K-3K OHM 30% LIN 1/4W	28480	2100-0377	1	1
2100-0378	R:VAR COMP 1M-500K-200K OHM 30% LIN 1/4W	28480	2100-0378	1	1
2100-0379	R:VAR COMP 10K OHM 30% LIN 1/4W	28480	2100-0379	2	1
2100-0380	R:VAR COMP 2.5K-250 OHM 30% 1/4W	28480	2100-0380	2	1
2100-0381	R:VAR COMP 25K OHM 30% LIN 1/4W	28480	2100-0381	1	1
2100-0382	R:VAR COMP 500K OHM 30% LIN 1/4W	28480	2100-0382	2	1
2100-0383	R:VAR COMP 5K OHM 30% LIN 1/4W	28480	2100-0383	1	1
2110-0002	FUSE:CARTRIDGE 2 AMP	75915	312.002	1	10
2140-0008	LAMP:NEON NE2	24455	NE2	3	3
2140-0018	LAMP:GLOW 1/10W	24455	NE 2E1	1	1
3101-0014	SWITCH:PUSH SPDT	82389	4S-1106	1	1
3101-0011	SWITCH:SLIDE	42190	4603	1	1
3101-0040	SWITCH:SLIDE 2 X DPDT 0.5 AMP	42190	6603 JM SPECIAL	3	1
5000-0743	COVER:SIDE-7x16 FM	28480	5000-0743	1	0
5060-0409	COIL	28480	5060-0409	1	1
5060-0627	ASSY:CONNECTOR	28480	5060-0627	1	0
5060-0761	BOTTOM COVER ASSY.,16L FM	28480	5060-0761	1	0
5060-0763	HANDLE ASSY-SIDE	28480	5060-0763	1	0
5060-0765	RETAINER:HANDLE ASSY.	28480	5060-0765	1	0
5060-0767	FOOT ASSY:FM	28480	5060-0767	5	1
5060-0776	KIT:RACK MOUNT	28480	5060-0776	1	0
5080-0419	NEON:AGED(GREEN)	28480	5080-0419	3	3
5083-0353	TUBE:CRT;P31 PHOSPHOR	28480	5083-0353	1	1
6980-0003	TRIM:PLASTIC	80509	6A-201	2	0

See introduction to this section

Table 6-2. **Replaceable Parts** (Cont'd)

Stock No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
8120-0078	CABLE:POWER 7.5 FT.	70903	KH 4147	1	1
9100-0169	TRANSFORMER:POWER	28480	9100-0169	1	1
9140-0022	COIL:FXD RF 500 UH	28480	9140-0022	1	1
9140-0157	COIL:FXD RF 680 UH	28480	9140-0157	4	1

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U. S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co., Phoenix Div.	Phoenix, Ariz
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
25365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.,	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostran Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. tube meeting EIA standards	Any brand Washington, D.C
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc	Norwalk, Conn
81349	Military Specification	-------
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.

Revised: Nov. 14, 1963
00015-34

F.S.C. Handbook Supplements
H4-1 Dated March 1963
H4-2 Dated March 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83058	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Conds Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83500	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83877	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Lloyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84401	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86097	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
92196	Universal Metal Prod., Inc.	Bassett-Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru-Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

Code No.	Manufacturer	Address
C0000	JFD Electronics Corp.	Van Nuys, Calif.
G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000O	U.S.A. Common	Any supplier of U.S.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc., Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000AD	Curtis Instrument Inc.	Mt. Kisco, N.Y.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A"N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

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Revised: Nov. 14, 1963

From: F.S.C. Handbook Supplements
H4-1 Dated March 1963
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CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from hp, are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard Field Office maintains a stock of replacement tubes and will be glad to process your warranty claim for you.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.

2) Wrap the above in heavy kraft paper.

3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5) Tubes returned from outside the continental United States should be packed in a wooden box.

6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CUSTOMER SERVICE

Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, 94306, U.S.A.
Telephone: (415) 326-3950
TWX No. (415) 492-9363

CRT WARRANTY CLAIM

FROM: DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

_____

_____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

_____

_____

To process your claim quickly please enter the information indicated below:

1) ® INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

_____

_____

_____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure _____

_____

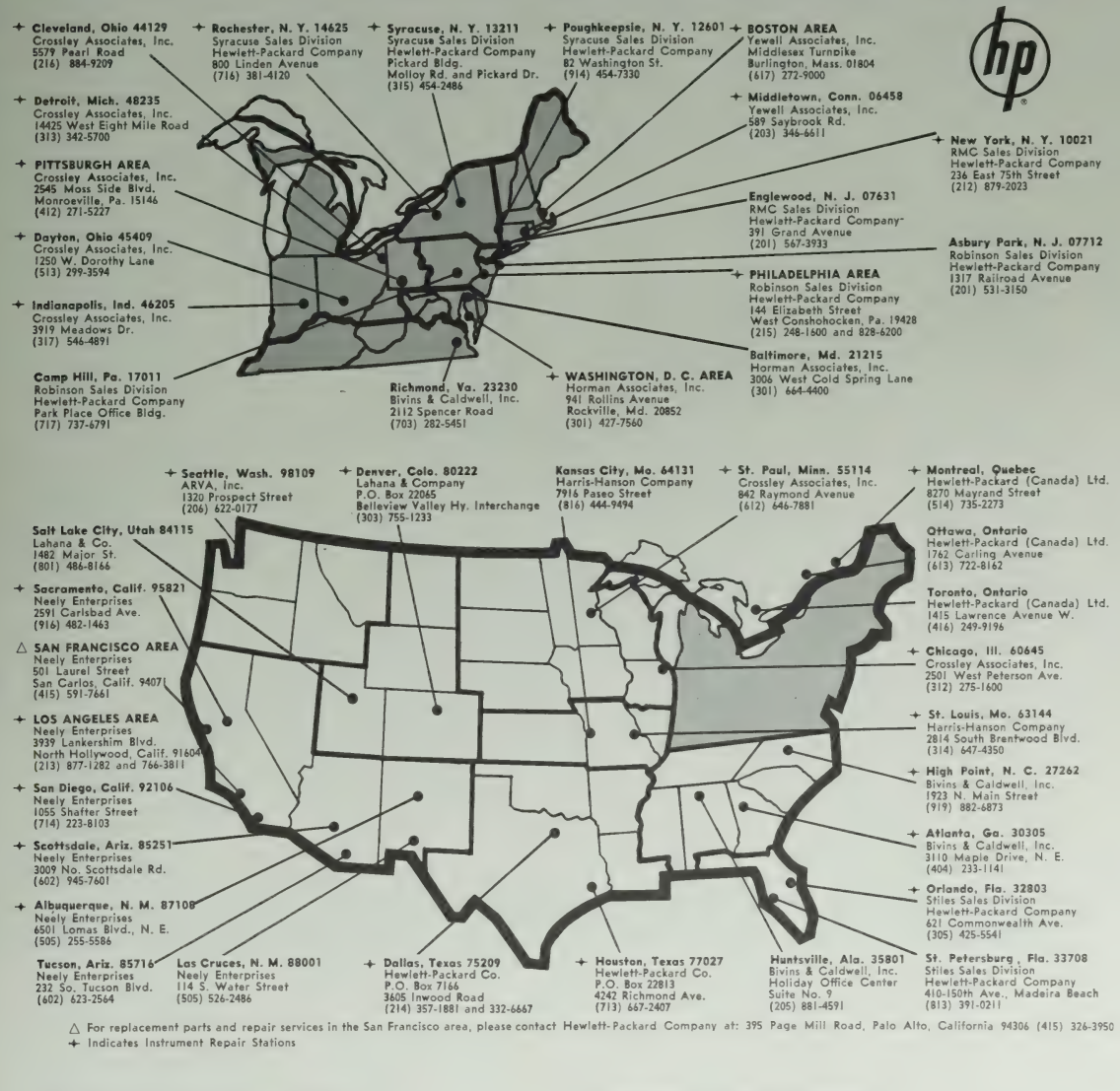
_____

_____

SIGNATURE _____

_____

HEWLETT-PACKARD SALES AND SERVICE OFFICES IN NORTH AMERICA



△ For replacement parts and repair services in the San Francisco area, please contact Hewlett-Packard Company at: 395 Page Mill Road, Palo Alto, California 94306 (415) 326-3950

✦ Indicates Instrument Repair Stations

HEWLETT-PACKARD COMPANY
1501 Page Mill Road • Palo Alto, California 94304
Tel: (415) 326-7000 • TWX: 415-492-9200 • Cable: HEWPACK

DYMEC DIVISION
395 Page Mill Road • Palo Alto, California 94306
Tel: (415) 326-1755 • TWX: 415-492-9363

BOONTON RADIO COMPANY
Green Pond Road • Rockaway, New Jersey 07866
Tel: Oakwood 7-6400 • Cable: BOONRACO

HARRISON LABORATORIES
41 Industrial Road • Berkeley Heights, N. J. 07922
Tel: 464-1234 • TWX: Summit, N. J.

SANBORN COMPANY
Industrial Division • 175 Wyman St., Waltham, Mass. 02154
Tel: (617) TW 4-6300 • TWX: 617-894-0789

F. L. MOSELEY CO.
409 N. Fair Oaks Ave. • Pasadena, Calif. 91102 • Tel: (213) MUrray 1-0208 • TWX: PASA CAL 7687 • Cable MOCOPAS

AUTHORIZED SALES AND SERVICE OFFICES IN WESTERN EUROPE

HEWLETT-PACKARD S.A.
54 Route des Acacias
Geneva, Switzerland
Telephone: (022) 42.81.50
Telex: 2.24.86
Cable: HEWPACKSA

Sweden
✦ H-P Instrument AB
Centralvagen 28
Solna Centrum
Tel: 08-83.08.30 and
10-83.08.30

Norway
Morgenstierne & Co.
✦ Wessels Gate 6, Oslo
Tel: 42.99.93

Netherlands
Hewlett-Packard Benelux
✦ 23, Burg. Roellstraat, Amsterdam W.
Tel: 13 28 98 and 13 54 99

United Kingdom
Hewlett-Packard Ltd.
✦ Dallas Road
Bedford, England
Tel: Bedford 68052

Belgium
Hewlett-Packard Benelux
✦ 20-24 Rue de l'Hopital, Brussels 1
Tel: 11.22.20

France
Hewlett-Packard (France)
✦ Boulevard Massena 150
Paris 13e

Portugal
TELECTRA
Rua Rodrigo da Fonseca 103
P.O. Box 2531
Lisbon 1
Tel: 68 60 72
68 60 73
68 60 74

Finland
INTO O/Y
P.O. Box 153
✦ 11 Meritullinkatu, Helsinki
Tel: 66.39.09 and 35.125

Denmark
Tage Olsen A/S
✦ Centrumgården, Room 133
6D, Vesterbrogade, Copenhagen V.
Tel: Minerva 6838

Germany
Hewlett-Packard V.m.b.H.

Steindamm 35, Hamburg
Tel: 24-05-51

✦ Sophienstrasse 8, Frankfurt am Main 6
Tel: 77-31-75 and 77-94-25

Severinstrasse 5, Munich
Tel: 49-51-21

Austria
Hewlett-Packard S.A.
Geneva

Yugoslavia
Belram Electronics
83 Av. des Mimosas
Brussels 15, Belgium
Tel: 35.29.58

Turkey
TELEKOM Engineering Bureau
P.O. Box 376 — Galata
Istanbul
Tel: 49.40.40

Spain
ATAIO, Ingenieros
A. Aguilera, No. 8, Madrid 15
Tel: 223-27-42 and 254-53-80

Italy
Dott. Ing. Mario Vianello
✦ Via L. Anelli 13, Milan
Tel: 553-081 and 553-811

Via S. Croce in Gerusalemme 97, Rome
Tel: 7.567.250 & 7.567.941

Switzerland
Max Paul Frey
✦ Wankdorffeldstrasse 66, Bern
Tel: (031) 42.00.78

Greece
K. Karayannis
Klaftmonos Square, Athens 124
Tel: 230.301 (5 Lines)

Authorized Sales and Service Offices in Other Areas

Argentina
Mauricio A. Suarez
Telecomunicaciones
Carlos Calvo 224, Buenos Aires
Tel: 30-6312

Australia
Sample Electronics Pty. Ltd.
✦ 9-11 Cremorne Street
Richmond E. 1, Victoria
Tel: 42-4757 (3 lines)

48 Chippen Street, Sydney
New South Wales
Tel: 69-6338 (6 lines)

India
The Scientific Instrument Company, Ld.
6, Tej Bahadur Sapru Road, Allahabad 1
Tel: 2451

240, Dr. Dadabhai Naoroji Road,
Bombay 1
Tel: 26-2642

11, Esplanade East, Calcutta 1
Tel: 23-4129

30, Mount Road, Madras 2
Tel: 86339

B-7, Ajmeri Gate Extn., New Delhi 1
Tel: 271053

Iran
Telecom Ltd.
P. O. Box 1812, Tehran
Tel: 43850

Israel
Electronics & Engineering Ltd.
✦ 16 Kremenetski St., Tel Aviv
Tel: 35021 (3 lines)

Japan
Seki & Company, Ltd.

Chushoku Building
✦ 9 2-chome, Nihonbashi Koami-cho
Chuo-ku, Tokyo
Tel: (860) 4121-5

Sumi Bldg., 106 Umegae-cho
Kita-ku, Osaka
Tel: (362) 8151-5

Korea
American Trading Company, Korea, Ltd.
Song Bo Building
112-35 Sokong-Dong, Seóul
Seóul P.O. Box 1103
Seóul
Tel: 3-7049, 3-7613

New Zealand
Sample Electronics (N. Z.) Ltd.
8 Matipo Street
Onehunga S. E. 5, Auckland
Tel: 565-361

Puerto Rico & Virgin Islands
San Juan Electronics, Inc.
P.O. Box 5167
Pta. de Tierra Sta., San Juan
Tel: 722-3342, 724-4406

South Africa
F. H. Flanter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street, Cape Town
Tel: 3-3817

Taiwan (Formosa)
Hwa Sheng Electronic Co., Ltd.
21 Nanking West Road, Taipei
Tel: 4-6076, 4-5936

FOR SALES AND SERVICE ASSISTANCE IN AREAS NOT LISTED CONTACT:

International Marketing Department
Hewlett-Packard Company
✦ 1501 Page Mill Road
Palo Alto, California 94304 U.S.A.
Telephone: (415) 326-7000
TWX: 415-492-9200
Telex: 033811
Cable: HEWPACK

✦ Indicates Instrument Repair Stations

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Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
235-	1		
248-00211 to 00485	2		
248-00486 to 00535	2, 3		
248-00536 to 00660	2, 3, 4		

CHANGE 2 (Cont'd)

Section VI,
Add C243, C: fxd, .001UF, 10%; ℔ Stock No. 0160-0153; Mfr 56289; Mfr Part No. 192P10292.
C444: Replaceable parts information in manual applies.
R260: Replaceable parts information in manual applies.
R404: Replaceable parts information in manual applies.
R451: Replaceable parts information in manual applies.

CHANGE 3

Figure 5-18,
Change value of R300 to 15K ohms.

Section VI,
Change R300 to R: fxd, comp, 15K ohms ±10%, 1/2W; ℔ Stock No. 0687-1531; Mfr. 01121; Mfr Part No. EB 1531.

CHANGE 4

Figure 5-7,
Add R9, 220 ohms, in series between J1 and junction of C9-S2.
Add R10, 220 ohms, in series between J2 and junction of C10-S2.

Figure 5-16,
Add R209, 220 ohms, in series between J201 and junction of C209-S201.
Add R210, 220 ohms, in series between J202 and junction of C210-S201.

Section VI,
Add R9, R10, R209, R210, R: fxd, 220 ohms ±10%, 1/2W; ℔ Stock No. 0687-2211; Mfr 01121; Mfr Part No. EB 2211.

MANUAL CHANGES

MODEL 130C

OSCILLOSCOPE

Manual Serial Prefixed: 235-
Manual Printed: Jan 1964

Make all changes in this manual according to the Errata below. Also check the following tables for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
235-	1		
248-00211 to 00485	2		
248-00486 to 00535	2, 3		
248-00536 to 00660	2, 3, 4		

ERRATA

Section VI,
Add R40, R: fxd, ww, 9 ohms ±10%, 5W; hp Stock No. 0813-0016; Mfr. 35434; Mfr Part No. C-5-9.
Note: Instruments with serial prefix 226- and the following serial numbers do not have resistor R40 (unless subsequently modified in the field):

235-00111	235-00133	235-00151
-00113-115	-00135, 136	-00153-155
-00117-119	-00141, 142	-00158
-00122	-00144, 145	
-00129	-00149	

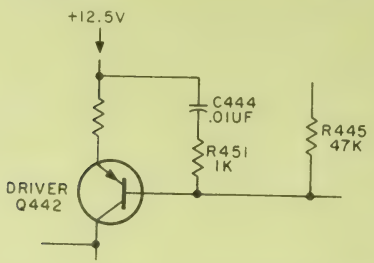
CHANGE 1

Section VI,
Change R404 hp Stock No. to 0687-2251, value to 2.2M ohms ±10%, and Mfr Part No. to EB 2251.

CHANGE 2

Figure 5-16,
Add C243, 0.001 UF, in parallel with R258.
Add R280, 12K ohms; connect between pins 2 and 8 of V203.

Figure 5-20,
Add C444 and R451 as shown below:



Change value of R404 to 2.0M ohms.

MANUAL CHANGES

MODEL 130C

OSCILLOSCOPE

Manual Serial Prefixed: 235-
Manual Printed: Jan 1964

Make all changes in this manual according to the Errata below: Also check the following tables for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:
NOTE: These changes apply to an instrument as manufactured and do not apply to subsequent field modifications.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
226-00101 to			
226-00110	1		
226-00051 to			
226-00100	1, 2		

CHANGE 1

C302: Change to capacitor, 200 pf; hp Stock No. 0140-0090.

R302: Change to resistor, 110K ohms; hp Stock No. 0686-1145.

Add R303: Resistor, 1K ohm; hp Stock No. 0687-1021.
L301: Inductor, 200 uh; hp Stock No. 9140-0019.
Parallel R303 and L301 between the junction of R304 with C303 and terminal 7 of T301.

Delete R303: Resistor, 100 ohms in cathode circuit of Oscillator V301 (short circuit).

CHANGE 2

Delete: R431 (short circuit).
R450 (open circuit).
C442 (open circuit).
C53 (open circuit).
DS101 (open circuit).
R159 (open circuit).

R114: Change to resistor, 270K ohms; hp Stock No. 0687-2741.

R85: Change to resistor, 8.2K ohms; hp Stock No. 0687-8221.

R401: Change to resistor, 15K ohms; hp Stock No. 0687-1531.

Gate output from sweep generator board (A101) to high-voltage power supply board (A301): Change to unshielded WHT/GRN/GRA wire.

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your nearest Hewlett-Packard field office for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your nearest Hewlett-Packard field office is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE

Hewlett-Packard Company
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U.S.A.
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OR (In Western Europe)

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Geneva, Switzerland
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